“SWOT Analysis of Renewable Energy Projects”

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ABSTRACT

India is one of the fastest growing country in the world. The faster growth rate triggers to the growing demand of energy and electricity. As energy in the form of electricity, is the heart of Industrial and economic development of every country, it needs to explore the sustainable way of bridging the gap of increasing demand of electricity. In view of which, it becomes imperatives to analyses the sustainable option for production of electricity. At this point of time, it is widely accepted that vast potential of emerging renewable energy sources can be utilized for the production of sustainable electricity with the installation of renewable energy projects at various part of India. However, it is pertinent to say that renewable energy projects in India is still facing various constraints in reference to the harnessing of renewable energy sources, in spite of tremendous potential of sources available in country. It is needless to say that Researcher is emphasizing and attempting to encase fully the potential available in our country by identifying and analyzing the Strengths, Weakness, Opportunities and threat of Renewable Energy Projects particularly utility scale solar and wind energy projects for bridging the gap between available potential and achievements of the national renewable energy targets in close coordination with various stakeholders involved in the utility scale renewable energy projects.

The present research study was undertaken to understand the various factors and issues, constraints and weaknesses which restrict the implementation of renewable energy projects in India through the structured questionnaire survey and interview of various group of stack holders in the field of renewable energy projects. Under this research study, the term utility scale renewable energy projects is being considered which mean large scale renewable electricity generation projects either solar photovoltaic (PV) or on shore-wind project at a scale larger enough to be classified as utility-scale and directly connected on electricity grid to feed power to utilities. According to ``National Renewable Energy Laboratory`` (NREL) a 5MW threshold to qualify as utility-scale renewable energy projects. The researcher accordingly, considering the research problem statement and main research objectives of this research study, has decided to use the term `renewable energy projects`.

The chapterisation plan for PhD thesis to be submitted is scheduled into six chapters. Over and above, the researcher also provides Content, List of tables, List of Figures, List of Abbreviations, Definitions of important words used in the report along with supported Annexure as per the cases followed by references and bibliography.

The first one chapter categorised as `Introduction` related to the subject matter brings out the importance of the research study, also represent the brief of the energy scenario, various renewable energy sources, renewable energy targets and potential in India. It also, covers the concept of SWOT analysis. The chapter number two categorised as `Review of Literature`. The review of literature consist of three sections, the first section reviews the literature on renewable energy sources and renewable energy development relating to global, national and state. The second section focus on the review of literature on National & global renewable energy policies and regulations, renewable energy projects investment, risk, barriers & constraint and third section elaborates the review of literature on Renewable energy SWOT analysis, cost competitiveness and cost analysis. The chapter number three `SWOT Analysis` narrates the dimensions and frame work of SWOT analysis related to renewable energy projects. The chapter number four of the thesis covers the important chapter entitled and dealt with `Research Methodology` in which the complete research methodology is represented in graphical form to understand the complete scenario of research. The chapter number five consist of `Data Analysis and Interpretation` for the research study, which analyse and provides the result of the research study and also covers the result of test of significance or Hypothesis with the support of different statistical tools and techniques to came up with implications of this study. The last chapter of the study entitled as `Conclusion, Recommendations and Suggestions` offers the abridged form of the PhD Thesis. This section concludes with the Recommendations, Suggestions, and Limitations of the research study. The secondary sources of information and data collected for the study are enlisted in the section of the `Selected References` are given at the end and lastly the `Appendix` have different annexures which provides detailed information on computations and clarifications on data analysis and interpretation as well as other information related to the research study. Under the conclusion, researcher likes to outlines a set of specific recommendations which will most possible helpful to various institutions, renewable energy industry, organizations, academicians, researchers and every stack holders in the field.

Chapter-1 Introduction

1.0 Introduction:

Energy is integral part in the industrial & economy development in particular and social development in general. For every industrial, business as well as social process, energy is essentially needed for their developments, creation of new values and or accomplishment of things. Hence, energy or energy production in the form of electricity has a direct impact on the industrial, commercial, social and economic development of every country in the worlds.

In view of which, one can say that electricity industry has a major foot print to shape the development pattern of any country in the world. The worldwide economic scenarios presently turn over to the radical changes in innovative technological up gradation with the sophisticated development of Industrial organisations which ultimately needs the uninterrupted continuous source of electricity for sustainable growth and development. The country having developed, efficient and sustainable energy sector with uninterrupted secure energy supply, almost negligible impact on environment and at the same time available at reasonable prices of energy resources, results in multilateral growth of that country with competitive effect.

Electricity is not limited to the sustainable growth and development of any industries but also supports for sustainable growth & development of agriculture, transports, and communications. It is envisaged that energy consumption all over the world has been continue increasing at comparatively faster rate due to increased population and socio-economic development.

1.1 Energy Scenario of India:

As per IBEF, August 2020 (India Brand Equity Foundation), an arm of the Indian government's ministry of commerce and Industry. ``India is the third largest producer of electricity as well as the Second largest consumer of electricity in the world. Moreover, the India is the fifth largest installed power capacity in the world. As per CEA report August 2020 (Central Electricity Authority), ``the total installed power capacity reaching

to 372.70GW out of which renewable energy project capacity reaching to 88.80GW includes solar project capacity of 35.74GW and 38GW of wind project capacity.

Since independence, the electricity installed capacities has grown up more than 300-fold, growth in demand has been even higher due to accelerated economically growing activity.

Thus, Indian power sector is undergoing a massive change that has redefined economic and industrial growth in sustainable manner with maintaining their growth continuously to meet Indian electricity demand in future. This has been envisaged through the government of India`s drive for 24x7 affordable and quality 'Power for all' in the country by March 2019, which further intend to accelerate capacity addition and adequate necessary infrastructure in the country.

1.2 Understanding Renewable Energy:

Since the research projects undertaken relates to the renewable energy projects, it felts necessary to have clear information, knowledge and understanding about the development and acceleration of renewable energy industry in world, particularly in India. In this context, a brief overview on renewable energy, its growth, perspectives and future development is described herein.

In broad term, the main energy resources are divided into two categories called non-renewable energy and renewable energy

The term ``Renewable Energy`` is exactly what it sounds that `energy which can be renewed`. Unlike other fossil fuel like oil, coal or gas which can`t be renewed and be a limited sources.

Renewable energy also termed as ``Alternate Energy`` or ``Green Energy`` or ``Clean Energy``, resources are unlimited natural resources that can be abundant does nor deplete the natural resources and replenished in a shorter period of time, which creates very little to no environmental pollutions during the process of its production or utilization. The history evident than in past, even after such comparable benefits of renewable sources of

energy, the utilization of natural resources are not being explored to the possible extent, might be due to its unique challenges posed by the green sources of energy.

1.3 Renewable Energy Sources:

The main forms of renewable energy sources are depicted here under:

Solar Energy:

Solar Energy is one of the most popular types of renewable energy in the world. The sun radiates light and the energy is harvested directly from sunlight's with the use of solar panels and converted it to electricity.

Wind Energy:

The power of wind is captured with the help of wind turbine, which rotates due to wind flow and generates electricity. Wind turbines now a day, increasingly popular for the utility scale of operation.

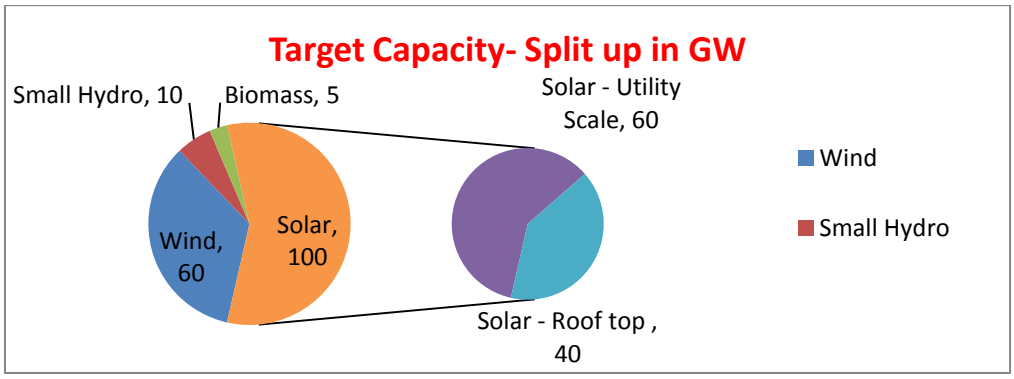
1.4 Renewable energy scenario in India:

India has evident a record of continuous development in renewable energy. As far as installed Renewable Energy power projects is considered, the India ranked Fourth Wind Energy project installed capacity, Fifth ranked in Solar Energy project capacity and Fifth global position in overall Renewable Energy project capacity installed as of 2020``

1.5 Renewable energy Target in India:

The Government of India during 2014-15, has set a target of 175 GW renewable power install capacity by 2022. The details split up of target capacity are shown as under:

Graph-1: Split up of target capacity of 175GW up to 2022 in India



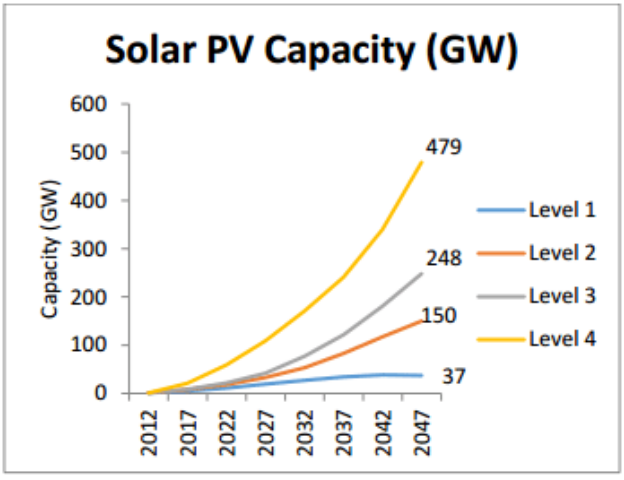
1.6 Renewable Energy Potential in India:

As per (NITI Ayog , 2015) for India`s 2047 Energy Calculator for Renewable Energy the various forms of renewable energy has tremendous potential of RE project development, the potential of various renewable energy sources`` i.e. Solar Photovoltaic Projects and wind power projects both, at different level of effort are demonstrated in the form of table.

1. **Trajectory of Solar PV Projects:** The trajectory scenario of solar power projects capacity during the year 2012 and year 2047 with different drivers & assumption along with different level of difficulties is presented in graph.

Level	Assumption/level of difficulty
1	✓ Solar PV capacity addition assumes lesser than the predicted under NTP or JNNSM ✓ Cost of solar projects continue to be high ✓ Challenging variable solar power integration
2	✓ Solar PV capacity addition assumes as per prediction under NTP or JNNSM
3	✓ Cost of solar projects assumes to be gradually falling hence economically competitive ✓ Solar PV capacity addition assumes slightly higher than predicted under NTP or JNNSM
4	✓ Assume no any barrier including land, evacuation constraint at all for the growth of solar PV projects ✓ Further assume sharp fall in solar PV prices ✓ Assumes availability of reliable smart grid, forecasting scheduling and dispatch of renewable energy power, energy storage system etc ✓ Meeting RPO as per target MNRE / state

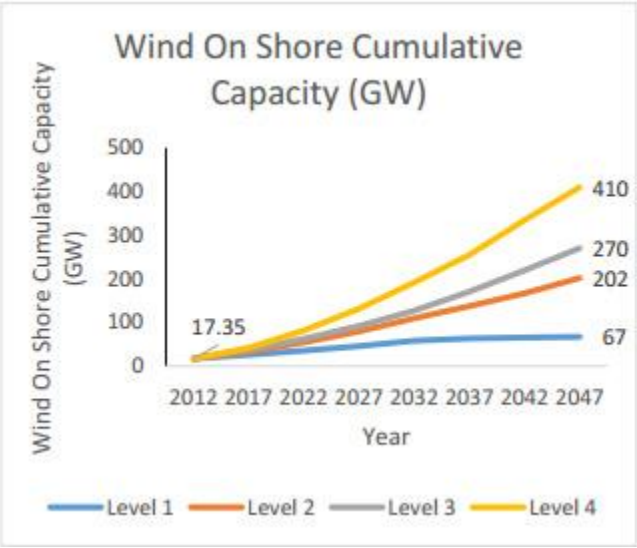
Graph-2: Trajectory of Solar PV project capacity at different level of difficulty 2012-2047



2. **Trajectory of Wind power Projects:** The trajectory scenario of wind power projects capacity during the year 2012 and year 2047 with different drivers & assumption along with different level of difficulties is presented in graph.

Level	Assumption/level of difficulty
1	✓ Wind capacity addition assumes lesser than the predicted under 12th plan or NAPCC targets ✓ Challenges of integrating variable wind power
2	✓ Wind capacity addition assumes as per 12th/13th plan prediction (32.35GW) ✓ Strengthening of evacuation & transmission system/planning of green corridor
3	✓ Wind power project capacity addition assumes slightly higher than predicted under 12th/13th Plan ✓ Undertaken effect of repowering of wind power projects and turbine capacity & increased hub height
4	✓ Assume no any barrier including land, evacuation constraint at all for the growth of wind power projects ✓ Further assume sharp fall in wind projects prices ✓ Assumes availability of reliable smart grid, forecasting scheduling and dispatch of renewable energy power etc ✓ Energy security considered in energy planning

Graph-3: Trajectory of Wind power project capacity at different level of difficulty 2012-2047



1.7 Dimensions of SWOT Analysis:

Every project or industry intend to operates in the positive, proactive, supportive, encouraging and protective environment which supports for the development of industry, its related environment, their employees, society and nation as a whole. Each project or a industry or a organization shall operates within its ambience of four dimensions say Strength, Weakness, Opportunity and Threat dimensions comprehensively well known as SWOT dimensions. In order to abstract the benefits of each dimension it is utmost essential to identify each of the dimensions with reference to that industry or a project and analyses the impact with respect to each of the four SWOT dimensions mentioned over here. The dimensions of strength within and outside the projects are to be manifested as competency of the project. The dimensions of the SWOT is further classify into tangible and non-tangible, such as tangible strength and non-tangible strength. The tangible strengths are the dimension which includes the equipment, general infrastructures of the projects, advanced technological system used in the projects, capital items. Material and equipment manufacturers and suppliers, EPC consultants and project developers etc. The intangible strength includes policy supports from governments, financing from government and non-government, experience of the project developers, power purchasers supports, positive supports from the government and policy makers decision towards projects, co-cordial relation amongst the government, policy makers, developers, EPC agencies, consultant financiers and investors, encouragement by the government for development of renewable energy projects, awareness and knowledge/ capacity building. Both the tangible and non-tangible strengths are generally supportive and positive dimension in the development of the industry or projects. However, it is not to be considered as the universally consensus that the strength for one project shall be the strength of other projects, as it depends on project to projects. Similarly for weakness the two categories are tangible weakness and non-tangible weakness.

1.8 Framework of SWOT analysis:

SWOT Analysis is one of the effective framework to evaluate a company's or a Projects competitive position in the market and is used for developing strategic planning of any companies or projects and identification of strength, weakness, opportunities and threats

involves in the business or projects, which supports to achieve the objectives for projects by identifying and analyzing the situations internally or externally, the result of which is utilized for the development of the project. The identified strength of the projects is utilized to compensate the threat and the identified opportunities of the project can be utilized to overcome the weakness of the projects. SWOT analysis identifies the risk and barriers which restrict the achievement of the objectives and development of the project. A SWOT analysis framework is designed in such a holistic manner that facilitates a realistic, fact-based and data-driven set up for the strengths, Weaknesses. Opportunities and Threats by scanning the complete system related to the business competitions, government policies or other threat of any projects or company / organization or any Industry. The SWOT analysis therefore, involves identification of core strength of the project/company, weakness, opportunities involved and the threats of the business that leads to fact-based analysis, development of new ideas for tapping the potential market and fresh new perspectives of the business. The SWOT analysis put forward additional value, once it is analyzed with realistic data obtained from the diverse group of stack holders within the organization or various organization of the same business. The influential factor for SWOT analysis of utility scale renewable energy projects is the project developers/organisations internal issues as well as external factors which anticipate the changes involved in projects affecting the existing and future development of the project & its targets. In case of Renewable Energy Projects, the various factors are numerated with reference to the objective of the topic.

i. **The Internal factors (strength & weaknesses):** Project developers organizational Structure (Resources, availability, designing for project)! Stakeholders (employers, employees, management, investors, policy makers, off taker) Customers (consumers of renewable power) Competitors (project competitor, manufacturers)

ii. **The External Factors (Opportunities and Threats):** The external factor includes the Technology, Economy, Politics, Government policies, Regulations and Society as well.

Chapter-2 Industrial Profile

2.0 Introduction:

Since last decades, the demand of the power has been growing. With this growing demands of electricity, **the development of renewable energy projects including solar & wind power project are also growing but not at par with the renewable power requirements due to their challenges, barriers, weakness and threats involved in the renewable energy projects**, mostly related to the renewable energy business markets. However, besides this factors, the India`s major strength today and going forward is that India is blessed with fairly high solar radiation with around more than 300 sunny days as India is located on the sunny belt of the world, which makes the region very appropriate for harnessing solar renewable energy source. Over and above this, India is endowed with fairly high wind potential, for harnessing the wind power also. Hence, the renewable energy projects potential is high and mostly untapped.

In order to tap India`s renewable energy potential fully over the next coming years, India will requires the new initiatives from central as well as State governments – beyond the policy and incentive programmes currently in place, which support the active participation and engagement of all renewable energy projects industrial sector – stack holders including developers, EPC agencies, policy makers, grid operators, IPP`s, research & development institutions, public & private financial institutions, consumers & related all.

With the given backdrop of challenges and strength, the government of India Ministry of Power, has constituted a full time ministry called Ministry of New & renewable Energy (MNRE) with supportive steering committee and Ayog for analysis, assessment and practical as well as approachable policy framework.

2.1 Institutions involved in RE projects:

Ministry of New & Renewable Energy (MNRE) (www.mnre.gov.in): MNRE is a nodal ministry of the central government deals in all the matters related to new and renewable energy and executing the function of deployment & development of renewable energy for

supplementing the energy demands of the nation. The responsibility of MNRE is significantly increased during a recent due to growing need of the alternative energy. MNRE is the nodal ministry for all matters relating to New and Renewable Energy covering scope of renewable energy projects:

- Solar Energy
- Wind Energy
- Mini hydro power
- Bio-mass, bio waste
- New energy sources such as Hydrogen, geo thermal, tidal power etc and Co-ordinating ministry for Bio-fuel policy and R & D.

  For promotion, development, co-ordination and financing of renewable energy projects, the ministry is having following five specialized technical & financial institutions:

1. **National Institute of Solar Energy(NISE):**
   - Converted 25 years old Solar Energy Centre (SEC) to NISE in September 2013
   - An Autonomous Institution
   - Located in Gurugram, Haryana
   - Apex national R & D institution in the field of Solar Energy
   - Assist ministry in implementation of National solar mission, R & D, technology, training & skill development, consultancy & related works.
2. **National Institute of Wind Energy (NIWE):**
   - Set up in Chennai, Tamilnadu in the year 1998
   - An autonomous R&D institution
   - Apex national R & D institution in the field of Wind Energy.
   - Dedicated knowledge base institution for research, technology, training & skill development in the spectrum of wind energy
3. **Solar Energy Corporation of India (SECI):**
   - Established on September 2011, incorporated as a section-25 (not for profit) company under the Companies Act, 1956
   - Dedicated Central PSU to the solar energy sector located at New Delhi
   - Facilitate for implementation of JNNSM and achievement of targets set therein

4. **Sardar Swaran Singh National Institute of Bio-Energy (SSS-NIBE):**
   - an autonomous R&D institution, located in Kapurthala (Punjab)
   - A Global Centre of Excellence in the Bio-Energy, Biofuels & synthetic fuels
   - Facilitate R & D, design, technology standardization and demonstration projects
   - Development of hybrid / integrated energy systems,
   - Facilitate training and human resource development including up to postdoctoral research.
5. **Indian Renewable Energy Development Agency (IREDA):**
   - A Non-Banking Financial Institution formed during March 1987
   - Act as Executive Agency for new & renewable source of energy (NRSE) programme
   - Facilitating term loans for promotion & commercialisation of renewable energy projects.
   - Financially assisted by Government of Netherlands, World Bank, Asian Development Bank (ADB), Danish International Development Agency (DANIDA)

2.2 State Nodal Agencies:

The MNRE has established state nodal agencies in union territories and different states of India specifically for bearing the responsibilities of promotion, development, co-ordination and growth of renewable energy projects in the respective states. It covers the promotion & development of private sector projects as well, by means of providing required clearances, facilitate in allotment of land, registration and approval renewable energy projects in their states etc.

2.3 Institutional Structure– Central level:

1. **Central Electricity Authority (CEA)** (www.cea.nic.in): CEA –established as a part-time body in 1951 and full time body in 1975, constituted under Electricity Act to perform statutory function of providing support to Ministry of Power for formulating policies, National Electricity Plan every five years for optimum utilisation of available renewable resources in the country. The other duties & function includes finalising technical standards & regulations, to carry out project monitoring, creating data base, promote R & D and state-of-the art technology in the power sector.

2. **Central Electricity Regulatory Commission (CERC)** (cercind.gov.in)**:** CERC is a statutory body constituted under the provision of erstwhile Electricity regulatory Commission Act 1998 and continued under Electricity Act 2003, Responsibilities to discharge includes mandatory functions of regulation of tariff for generation, inter-state transmission & sale of electricity controlled by central government and intra-state, adjudicate up on disputes for the same, specify grid standard, fixing power trading margin, and other advisory functions of formulation of NEP, tariff policy and promotion of investment, competition, economy, efficiency in electricity industry.
3. **Forum of Regulators (FOR)** (forumofegulators.gov.in): FOR constituted in 2005 in pursuance of the provision under Electricity Act, 2003, consisting of chairperson of CERC as the chai person of FOR and chairpersons of SERC`s. FOR discharges the functions of analysis of tariff orders of central & state commissions, harmonising the regulations in power sector, formulating standard of performance, takes measures for protection of consumers, promotion of competition, economy, efficiency in power sectors.
4. **Central Generator Utility (NTPC)** (www.ntpc.co.in): NTPC – largest power generating company in India, incorporated on 1975, with prime aims is to be the world`s largest and best power producers. Commensurate with the India`s growth challenges, NTPC embarked up on the ambitious plan of developing the green field power projects including large utility scale solar and wind power projects at various areas of the country. NTPC plan to a significant project capacities of renewable energy portfolio to the tune of 32GW capacity up to 2032.
5. **Central Transmission Utility (CTU): PGCIL** (www.powermin.nic.in): The Power Grid Corporation of India Limited (PGCIL), the CTU of the national and a `Navaratna` company operating under the Ministry of Power, incorporated during 1989 and engaged in providing transmission system for evacuation of power and bear the responsibility for planning, implementation, establishment and operation of national & regional power grid / Inter-state transmission system (ISTS) to facilitate transfer of power within & across the region with reliability and economically.
6. **Northern Regional Load Dispatch Centre: (NRLDC)** (www.nrldc.in): The integrated operation of national & regional power system is operated by **Power**

System Operation Corporation limited (POSOCO), constituted in 2009 to execute the power management functions of PGCIL, Further, separate company is formed in 2017 entrusted the functions of load despatch. **T**he main functions involves supervision, control, planning, co-coordinating & implementation of infrastructure required for smooth operation and functioning of national Load Despatch Centre (NLDC) and all five Regional Load Despatch Centre (RLDC)

7. **Indian Energy Exchange (IEX): (**www.iexindia.com): IEX operating since 2008 and regulated by CERC. IEX is the largest emerging nationwide automated trading platform in India for physical delivery of Renewable Energy Certificate (REC) and Energy Saving Certificate (ESCerts) and trading of electricity. The trading platform enables efficient electricity price discovery with transparency of Indian power market.

2.4 Institutional Structure – Gujarat State:

1. **Energy & petrochemicals Department GoG** (www.epd.gov.in)**:** Responsibility includes overall planning & budgeting for development, promotion of electricity including renewable energy in the state of Gujarat. Assist central government for adoption and promotion of policies enacted by GoI and achievement of government target given time to time.
2. **Gujarat Electricity Regulatory Commission (GERC)** (www.gercin.org)**:** The GERC is a statutory body constituted in 1998 as per the provisions of Electricity Regulatory Commissions Act 1998 and continued in the Electricity Act 2003. GERC carry the responsibility of regulating the electricity sector of Gujarat with determination of tariff of electricity and grant of licences at intra-state level and effectively promoting the renewable energy projects, determination of tariff, specify the grid codes, adjudicate upon the disputes between customers, licensees, generating companies, assisted by various committee formed like State Advisory Committee, the Co-ordination Forum of all the power utilities of the State and the Consumer Grievance Redressal Forums who address the issues relating to both consumers and electricity companies. GERC has been taking effective steps in promoting renewable sources of energy.

3. **Gujarat Energy Development Agency (GEDA)** (www.geda.gujarat.gov.in)**:** GEDA is the premium organization and a state nodal agency for the Ministry of New and Renewable Energy. The responsibility covers the promotion and development of long term renewable energy economically and commercially and implementation of policies related to renewable
4. **Gujarat Power Corporation Ltd:** (gpcl.gujarat.gov.in/)**:** A state Government Company promoted by Government of Gujarat, incorporated in June 1990 under the companies Act 1956. Company is designated nodal agency for development of Solar Park by acquisition of lands for solar park, providing facility of required resources like water, transmission facilities, and evacuation of renewable power from solar Projects.
5. **Gujarat Urja Vikas Nigam ltd** (www.gseb.com)**:** State owned Government of Gujarat Company engage for procurement of bulk power, sale of electricity to distribution companies of Gujarat and trading licensee for intra state power trading. Execute the power purchase agreement with the generator both PSU and private renewable energy projects as well.
6. **Generation Utility:** State owned generation utility as Gujarat State Electricity Corporation Ltd (GSECL), came in to existence after unbundling of Gujarat Electricity Board (GEB) during 2005 after electricity Act 2003 involved in the development of new conventional power projects including renewable energy projects at large scale both wind and solar projects for generation of electricity.
7. **Transmission Utility:** State owned transmission utility (STU) GETCO established in 1999 responsible for construction, operation & maintenance and transfer of power from generator / renewable energy projects to the DISCOM or to the industrial consumers. Company has built up programme of network capacity addition, transmission asset management, state grid stabilization & operation, smart grid operation for transmission of power from renewable energy projects
8. **State Load Despatch Centre (SLDC)** (www.sldcguj.com): SLDC, the apex body to ensure the smooth integrated operation of state power system, came into operation since 1069. The responsible for optimum real time operation & management of power flow within the state of Gujarat in accordance with the contract entered into with

power generating companies & distribution licensees, supervision, & control of real time grid operations as well as monitoring the quality of electricity supply as per state grid code & grid standards, supported by four Area Load Despatch Centres (ALDCs)

9. **DISCOMs:** Gujarat has four public owned electricity distribution companies incorporated under the companies act 1956 in 2003 as a result of unbundling of erstwhile Gujarat Electricity Board pursuant to Power Sector Reforms initiated by Central & State Governments. All the four DISCOMs are wholly-owned subsidies of GUVNL and have one privately owned company Torrent Power, Shoulders the responsibility of supply of quality and uninterrupted electricity to consumers of Gujarat, metering and billing of renewable energy electricity.

2.5 List of leading Stake holders in Renewable Energy projects:

Name of Stockholders	Name of Stockholders
• Tata Power Solar System Limited • Adani Green Energy • Azure • Greenko Energy Holding • Acme Solar Pvt Ltd • Engie Green Energy • Jinko Solar • Suzlon energy Ltd • Inox wind limited • Regen power tech Pvt Ltd • Orient green power Ltd • Enercon India pvt ltd • Gamesh Wind turbine Pvt Ltd	• L & T Renewable Energy • Sterling & Wilson • Mahindra Sustain • NTPS Renewable Energy • Renew Solar Power • BHEL Renewable Energy • Vikram Solar • Gujarat Energy Research & Management Institute (GERMI) • RPG group • Waaree Energies • Kosol Energies • Refex Energy Pvt Ltd

2.6 Stack holders – Role in Renewable Energy projects:

Stake holders	Role
Project Owner	The owner of the equity for the project and beneficiary in the generated income.
Project Developer	The owner of the project development, responsible for installation of the complete project & beneficiary in profit
EPC Contractor	Responsible for Engineering, Procurement & Construction of the Renewable Energy Project.
O & M Contractor	Responsible for Operation f the project after commissioning
Manufacturer	The manufacturer of equipment's used in the projects
Supplier	The Supplier of the equipment's & manpower for the projects

Land Owner	The Owner of the land on which project is established and get sharing in profit or lease rental from project developer
Power off-taker	The utility or electricity company who purchase power generated from the project on the base on power purchase agreement & responsible for payment to project developers.
Investor	The bank or institution who invest in the project and get sharing in profit / return on onvestment or certain amount of returns from project
Financier	The bank, institutions provides part of the fund on debt finance for the projects and get return as interest
Consultant	Who act as co-ordinating agency between developers & EPC contract & support for the project and obtain some fixed amount in lieu of services provided.
Policy maker	To collect information from various resources, stack holders & researcher to prepare set of policies best suitable to promote the renewable energy projects.
Regulator	Regulating the tariff through transparent procedure, development & promotion of RE projects and protection of consumers/ stack holders.
R & D Institutions	Research for the optimum technology in renewable energy projects, recommendations for development of projects
Academicians	Awareness & educate regarding the renewable energy project developments & technical knowhow.

Chapter-3 Review of Literatures

3.0 Review of Literature:

This chapter provides a quick over view of various empirical literatures available on the subject matter of renewable energy potentials, renewable energy policies, regulations and constraint, cost competitiveness, SWOT analysis etc based on renewable energy projects particularly utility scale solar PV projects and wind power projects with emerging issues related to the development in the renewable energy sources, technologies and projects. The literature on the subject matter is very large and hence it has been delimited to review some important literatures to outline the core issues.

The literature review is a previous work in the field of present study, review the critical perspective on the relevant literature including conclusive findings on the related subjects. The in depth literature review helps in identifying the research gap that will attempt to address and established to determine the focused problem of study on which research is to be conducted.

The literature review is presented in three sections;

- Section one provides a emerging literature on renewable energy sources and renewable energy development relating to global, national and state,
- Section two provides a scan of national & global renewable energy policies and regulations, renewable energy projects constraint and
- Section three deals with a present picture of the renewable energy SWOT analysis, cost competitiveness and analysis etc.

The review of literature has been presented as under:

Section-I: Literature on renewable energy sources and renewable energy development:			
Sr. No.	**Name of the Author & Year**	**Title of the Research Paper**	**Major Findings**
1	P. F. Rabia Ferroukhi (2018)	Renewable Energy Policies in a Time of Transition	Provides development options to support the renewable energies with scale up of renewables by technological innovation, market competition, and sharp

			cost reduction supported by enabling policies to achieve the global targets with remedial measures to integrate the variable nature of growing renewable production to the power grid.
2	Mohamed (2018)	"Renewable Energy Potential and Available Capacity for Wind and Solar Power	Studied the present situation of energy available renewable energy resources, challenges faced to tap the existing renewable energy potentials and strategy to meet the increased energy demand by increasing the total installed capacity of renewable energy by 2030.
3	IBEF (2018)	"Renewable Energy, India	Achievement of ambitious target of 175 GW by 2022 with recent increased competition, increased FDI inflows & adoption of competitive bidding through reverse auction strategy,
4	Rakesh Shah (2016)	Developments in Renewable Energy - Current Trends & Future Prospects Power Market in India – Way Forward."	Studied the potential of solar power & wind power indicates that huge untapped potential available to be harnessed. For achieving government target planned Green Energy Corridor with strong grid interconnection scheme, utility scale renewable projects driven by policies & regulatory supports, promote solar wind hybrid MW scale projects to reduce cost of land, evacuation, grid stability and identified the challenges posed in the Renewable Energy developments
5	Savita Lolla (2016)	Wind and Solar resources in India`."	Concluded that the grid connected solar and wind energy projects potential to feed five regional power grids in India and the variability of generation for both solar & wind resources driven by the annual solar cycles implied that both resources

			intermittency in the other grids addressed only by utilizing back-up power sources and operational challenges
6	IRENA & NREA (2014)	A Renewable Energy Roadmap	Provides a roadmap for doubling the global share of renewables in the energy mix focus on five specific areas, pathways based on the national plans global countries, Socio-economic impacts, Current situation & developments upto 2030 with implementation of all options, Improvement needed to improve the existing policy framework and opportunities for international co-operation of various governments.
7	Kolhare (2012)	renewable Energy Sources- Policies of India.	Presented that the consumption of electricity increased rapidly which created huge gap between demand & supply that energy gap bridged by utilization of huge renewable energy sources available through research & development in the field of renewable energy technologies and implementation of renewable energy projects
8	Soni (2010)	"`Unleashing the Potential of Renewable Energy in India` .	Suggested a few implementable measures that India can consider to tap its vast unharnessed potential. Report states that there is a tangible impact of policy and regulatory initiatives on the renewable energy growth, however there is need for adequate capital cost benchmarks, and investment assumptions used to arrive at acceptable returns for renewable energy investors. The note also focuses & categorizes barriers as financial viability issues, regulatory hurdles, and lack of support infrastructure.

Section-II : Renewable energy policies and regulations, renewable energy projects investment, risk, barriers & constraint:			
1	Labanya Prakash Jena (2018)	Getting to India's Renewable Energy Targets: A Business Case for Institutional Investment`.	Identify the key drivers for renewable energy investments in India, explores the alignment of the investment criteria of institutional investors with renewable energy and discussed identified barriers to renewable energy investments include off-taker risk, regulation, lack of adequate liquid financial securities, limited understanding of sector and currency risk, as well as strategies to overcome these barriers
2	Anand Kumar (2018)	"Ministry of New and Renewable Energy, GoI,	India needs $125-billion investments to more than double its renewable energy to the targeted 175 gigawatts in four years The Government stated to engage in innovative ways of financing renewables through masala bonds and investment through public & private companies
3	Tim Buckley (2018)	Electricity Sector Transformation in India A Case Study of Tamil Nadu."	Provided an excellent study for the potential to transform a regional electricity system, progressively increasing reliance on renewables while lowering average cost of electricity supply to meet the India`s ambitious plans for lower cost alternatives and doubles renewable energy installed capacity over the coming decade
4	IRENA & NREA (2018)	Egypt Based on Renewables Readiness Assessment and REmap analysis."	Studied the existing renewable energy policies, regulatory mechanism for the development of renewable projects, particularly for solar and wind projects and identified the challenges and limitations restricting the deployment of renewable projects and

			recommended strategies to meet the identified target with recommendation to mitigate risk, ensure financially viability, cost competitiveness, streamlining of policies & regulations,
5	Jose (2018)	"Indian Progress in the Renewable Technologies: A Review on Present Status, Policies, and Barriers."	Identified the available unused potential of various renewable energy sources for solar & wind projects in different states of India, summarized the present status, policies, and various barriers & constraints of renewable projects
6	IBEF (2018)	renewable Energy, Indian Brand Equity Foundation	Represented large scale government initiated expansion plans considering the robust growth of renewable energy by creating favourable policy environments by permitting 100 percentage FDI, creates attractive opportunities and results in arrival of ambitious renewable projects and increasing investment across the value chain, growth driver includes government policies
7	Dr. Arunabha Ghosh (2018)	Strategic Investment to Drive India's Renewable Energy Revolution,	Studied the renewable energy sector from the view of investors perspective, evident increased attractiveness and declining risk perception of stockholders reflected maturity stage by use of reverse auctions system of tariff discovery examined the evolving risk of policy & financial regulation on the renewable investment, the imposition of safe guard duty/anti-dumping duties on imported PV modules created uncertainty among the stakeholders
8	Veena Jha (2017)	Building Supply Chain Efficiency in Solar and	Studied that the development of solar and wind industries largely

		Wind Energy: Trade and Other Policy Considerations.	depends up on the government policies & supports, manufacturing renewable projects equipment in developing European countries no longer a viable option, even countries with indigenous capacity like India & Brazil finds uneconomical for domestic content requirements (DCR) solar photovoltaic (PV) modules, other challenges includes the financing, inadequate grid connectivity due to decentralized renewable projects
9	Amit Kumar, Sapan Thapar (2017)	Addressing Land Issues for Utility Scale Renewable Energy Deployment in India,	Studied to address the challenging land issues posed to both the policy makers as well as the project developers, for the development of utility scale renewable energy projects in India as till no comprehensive land utilization policy at national or state level leads to time consuming process for approval**,** land lease policy**,** higher cost of land
10	J. S. Rabia Ferroukhi (2017)	Accelerating the global energy transformation`	Focused on the rapid and continues increase of global renewable energy projects capacity and output at an unprecedented pace which set in motion a rethinking or transformation of the global energy system, with available policy, investment and innovation interventions along with new policies trends gradually shifted to suit changing market conditions from tariff based to auction.
11	Manpreet Sing (2017)	"Assessment of Sri Lanka's Power Sector - 100% percent Electricity Generation	Studied the challenge of de-risked policy environment, innovative financial models and practices to attract investment at

		through renewable energy by 2050."	scale in the renewable energy projects for development pathway while aiming for a true paradigm shift for 100% electricity generation through renewable energy targets by 2050 . The risk perception of investors includes various risk as Off-taker risk, Evacuation risk, Currency risk, Regulatory/Policy risk, Return risk, lack of renewable energy sector awareness etc.
12	Rachit Srivastava (2016)	Solar Power – Current Status, Challenges and Policies in India`	Concluded that some extra effort is required in terms of reviews existing government act, regulatory policies support and subsidize for development of solar projects. pointed out concern regarding various barriers and challenges as dependence of energy on weather conditions/ availability of solar radiation, huge land area required for utility-scale projects, energy sources is intermittent even though required huge investments
13	IRENA (2016)	Roadmap for a Renewable Energy Future, 2016	Described that the adoption of the Paris Agreement 2015, marks a turning point in the global energy transition to renewable energy, also shows how the world can double the share of renewable energy in the energy mix within timeframe along with perspective on the opportunities and challenges
14	Angel Gurría (2016)	policy and market fragmentation	Studied the policy and market fragmentation constrained the financing and investment in renewable energy projects, in spite of increased cost competitiveness in renewable market makes scaling-up investment critical, hinders the

			growth of bankable projects and affects the risk-return profile of renewable energy projects.
15	Liz McDaid (2016)	Opportunities for Investing in Renewable Energy Sector in Africa.	Studied that the increasing opportunities for investing in Renewable Energy projects in Africa to enhanced energy security, the attractiveness of the renewable market driven by regulatory framework and market design scheme of "one stop shop.Concluded that in spite of opportunities, the challenges and barriers are risky investment with costly regulation and application procedures
16	Dickson, Cora (2016)	Renewable Energy, A Market Assessment Tool for U.S. Exporters	Reported that the renewable energy sector stands most vibrant, dynamics and transformative industry among the global evident by fast technological up gradation, dramatic cost reduction, large scale development of projects, global supply chain India as an attractive market for solar however renewable energy projects is driven by policy hence any changes in policy have impact on cost competitive & attractiveness of market as happened with reverse auction process
17	Makwana (2016)	Solar Power Production and Policy of Gujarat: A SWOT Analysis,.	Analyzed the significant internal and external factors that have an impact on solar power production in the state of Gujarat, which blessed high solar radiations encouraged solar power generation potential to transform into an 'Integrated Solar Generation Hub'. Studied the major concern of policy and infrastructure barrier as well as threat of hazardous waste

			material management and its recycling process issues in future.
18	Megha Kaladharan (2015)	Renewable Energy in India: An Analysis of the Regulatory Environment and Evolving Policy Trends`	Analysed the existing constitutional and regulatory framework for the renewable power sector. The introduction of Electricity Act, 2003 marked paradigm shift in the Indian electricity sector provided several enabling provisions, with emphasis to promote accelerated development of renewable source based power generation & globally competitive model.
19	Daphne Mah , Jasper Ip (2014)	`a case study of the development of renewable energy in the Hong Kong-Guangdong region in China`	Examined the relationships between regional energy governance and technological innovation, identified three dimensions that affect technological innovation at a regional scale as the potential collaborative benefits, prioritized options and perceived critical barriers and knowledge gaps by adopting a bottom-up engagement approach and focused on three prioritized options as technological options, business and financing options, and policy and governance options
20	Ina (2014)	Employment Effects of Renewable Energy Supply A Meta-Analysis Policy	Concluded that the increased deployment of renewable energy projects into the energy mix of different countries indicates positive net effects of employment creation derived positive contribution to the labour market
21	Swami Prakash Srivastava (2013)	"solar energy and its future role in indian economy	Concluded in their study that India's solar market could be worth billions of dollars over the next decade due to enough solar potential and improving support

			environment, Project execution, financing, and localization are crucial as number of projects and players increases, procurement effectiveness with low-cost and often innovative financing required.
22	Echegaray (2013)	Understanding stakeholders' views and support for solar energy in Brazil."	Study revealed that Brazil is an ideal site for solar energy production due to large numbers of sunny days, optimal radiation intensity, and a wide geographic area with favorable decreased in solar equipment & installation costs and acceptance of corporate customers, stakeholders and opinion makers of business community both wind and sun power project but expectations for return on investment are affected by a sustainability penalty as well as by price and adaptation barriers.
23	Steve Sawyer, Nicolas Fichaux (2013)	30 Years of Policies for Wind Energy Lessons from 12 Wind Energy Markets	Identified and reviewed the significance policy and regulatory framework that contributed for successful development of rapidly growing wind energy projects, providing both cost-effective and scalable projects in different sizes of twelve markets of Brazil, China, Denmark, Germany, Greece, India, Ireland, Italy, Portugal, Spain, the United Kingdom and the United States India's wind energy project which identified the issues of grid integration, forecasting and scheduling, structural inefficiencies and reliability problems
24	Mohsen Rezaei (2013)	The Role of Renewable Energies in Sustainable Development: Case Study Iran.	Studied the Iran's energy system and found that country is much out of sustainability there is indicator of low share of renewable energy in the total

			energy electricity production even though there is tremendous potential & exceptional benefits of renewable energy and policy concept as well. Concluded that the Iran's energy policy for promoting of renewable energy is not yet implemented and suggested actions are increasing public awareness, policies to be framed for manufacturers, framing of supporting policies rules & regulations for growth, purchase & consumption of renewable energy.
25	Ashish Khanna (2013)	`Paving the Way for a Transformational Future Lessons from Jawaharlal Nehru National Solar Mission Phase I`	Stated that India is blessed with abundant solar insolation and solar projects potential, adopting of reverse auction method for price discovery of projects, identified the key barriers and constraints such as Lack of financing due to perceived risk in lending the projects particularly, in the absence of any risk-reducing mechanisms, persisted bottlenecks relate to land acquisition, delays in approvals at the state level, limited field-level data availability on solar irradiation, non-availability of support infrastructure
26	Sun-Joo Ahn and Dagmar Graczyk (2013)	Understanding Energy Challenges in India Policies, Players and Issues ,	Studied that with the introduction of Electricity Act 2003, the first regulatory framework open up the window to harness vast potential of renewable energy in India probably to attain "energy independence in the long run`` triggered the growth with inclusion of preferential tariff for renewable-based electricity projects and mandatory renewable purchase obligation

			(RPO) for power utilities led to the introduction of the Renewable Energy Certificate (REC), Concluded with the barriers and challenges of limited transmission infrastructure, land acquisition, capital costs & financing issues for renewable projects across India.
27	Govinda R. Timilsina (2011)	A Review of solar energy markets, economics and policies.	Attempted to address the issue of smaller share of solar energy in the global energy supply, studied the key barriers which prevented large-scale development of solar projects in the nation, policy & regulatory mechanism, barriers include feed in tariffs (FIT), tax credits, capital subsidies and grants, renewable energy portfolio standards (RPS), financing investments and other financial incentives.
28	IDFC (2010)	Barriers to development of renewable energy in India & proposed recommendations.	Studied on constraints, barriers and gaps prevalent in the current policy and regulatory system, emphasized to review the existing policies in favour of scale up of RE, recommended formulation of comprehensive policy and action plan for all-round development of the renewable project, barriers related to the Grid connectivity & transmission infrastructure requirements, fiscal incentives, Financing, establishment of subsidized manufacturing, increase awareness & technical knowhow.
29	Ms. Claire Swadkin (2010)	Renewable Energy Stakeholder Consultation Report	Studied on perceptions regarding renewable energy's potential, barriers, policies, regulations, financing, found absence of effective national

			policy and regulatory support mechanism. The perceived barriers include the financial crunch with high cost & non availability of finance, lack of government incentives, policy uncertainty, grid connectivity, insufficient skill and capacity constraints
30	Gevorg Sargsyan (2010)	"`Unleashing the Potential of Renewable Energy in India` Energy Sector Management	Focused on the economic feasibility and suggested measures to tap the available unharnessed renewable energy (RE) potential. The authors analysed the challenges and barriers consist the limited evacuation infrastructure and grid connectivity for undeveloped indigenous supply chain, Ineffective regulations, land and resource acquisition and delays in regulatory clearances, financial viability and bankability issues, however, suggested the measure like state wise enforcement of RPO and REC, explore new sources of funding such as green bonds, new equity, risk guarantee facility of renewable energy projects
31	Sudhakar Reddy (2004)	Diffusion of renewable energy technologies—barriers and stakeholders perspectives`	Surveyed various stakeholders such as consumers, equipment manufacturers, energy developers and policy makers/experts in Maharashtra State and studied the barriers to the adoption of renewable energy technologies viz., solar and wind, systematic classified economic, technological, market and institutional barriers, and analysed each barrier and described its mode of influence to develop policy measures to design innovative policy

			approaches to help realize the potential.
Section III: Renewable energy SWOT analysis, cost competitiveness and analysis etc			
1	Barbara Buchner, Henning Wuester (2018)	Global Landscape of Renewable Energy Finance, 2018."	Analyzed the renewable energy finance landscape, outlined key trends globally for Utility-scale solar PV and wind project, examined the differing roles and approaches of private and public finance, highlighted the important role of risk mitigation instruments, annual investment declined in 2016, however the capacity additions in the same year were up than 2015 partially due to declining costs of solar and wind power and policy changes to auction mechanisms instead of feed in tariff, contributed significantly hence each dollar of investment financed more capacity than in previous years.
2	Mercom india (2018)	"Mercom india Executive Summary (2018), India Solar Market Update	Forecasts that India will install about 8 to 9 GW of solar capacity during the running year 2018, cumulative large-scale solar capacity projects commissioned totalled 20.8 GW upto March 2018 with Karnataka was the leading state with over 5 GW of cumulative installed capacity, followed by Telangana, Rajasthan, Andhra Pradesh Tamil Nadu than Gujarat. The lowest auction rate received in Q1 2018 was Rs.2.91 (~$0.043)/kWh The forecasted utility based solar power project cumulative installations in India about 65GW upto 2022.
3	Surbhi Singhvi, Vinay Rustagi (2018)	India Solar Compas Q4, 2017, Bridge to India."	Reported that India's utility scale solar project total installed capacity reach to 17.5GW in the

			calendar year December, 2017, out of which maximum of total installed capacity is led by four southern states along with Rajasthan. Reported the developer wise project capacity commissioned and market share of international and domestic solar module suppliers, inverter suppliers, EPC contractors and reverse auction trends to discovered rate which is increased due to execution costs and increased risk significantly owing to increase in costs of modules plus imposition of GST and custom duties.
4	Andrei Ilas (2018)	Renewable Power Generation Costs in 2017	States that the renewable energy is offering increasingly exciting economic opportunities with rapidly falling renewable power generation costs mainly driven by continuous technological improvements, including higher solar module efficiencies, competitive procurement & supply chains, economies of scale, larger wind turbines, string of record-low auction prices for solar PV & onshore wind, internationally experienced & expertise project developers, purchasing power and access to international financial markets driving down project costs and risks.
5	Marcin Ścigan (2017)	Cost-Competitive Renewable Power Generation: Potential across South East Europe."	Report clearly indicates that solar PV and wind energy are already viable options for the region as most of the region's vast untapped renewable energy potential is unexploited. The major identified barriers include: the absence of a long-term stable renewable energy policy, inadequately designed

			Power Purchase Agreements (PPAs), high administrative barriers and technical challenges of variably renewable supply grid integration limitations
6	Hasret Balcioglu (2017)	Techno-economic modeling and analysis of renewable energy projects .	Studied the viability of renewable energy projects by techno-economic analysis with various models for the Southeast Asian Nations and analyzed the different indicators involved in viability and financial decision making like payback analysis, annual energy generation to offset investment, Time Value of Money, annuity factor of present value, Net Present Value (NPV), Internal Rate of Return (IRR), SWOT Analysis, Discounted Cash flow (DCF) Analysis, Levelised cost of energy (LCOE) and Breakeven Analysis.
7	Caneva (2017)	A New Opportunity For Financing Renewable Energy Projects	Studied the decelerated growth of renewable energy projects due to challenges in financing options in Europe, triggered the innovative financing concept of crowd funding mechanism for renewable energy project developers, stakeholders / contributors and online crowd funding platform, an intermediaries between public & project developers unleash the RE deployment potentials by bridging the partial funding gap for RE projects,
8	Allana (2017)	Valuation of First Solar Inc. A fundamental analysis of a solar company. Economics & Business Administration	Studied the First Solar Inc, U.S. based solar energy industry by porters five force model to examine the competition among the solar energy industries and found increased competition due to subsidies, emerging technology, entry of new firms

			to renewable sources
9	Donastorg (2017)	Financing Renewable Energy Projects in Developing Countries: A Critical Review	Studied current trends in financing Renewable Energy projects in developing countries It estimated that the renewable energy business is good investment opportunity however faces challenge to grow the business such as dependence on the government legal framework policies and regulations, implementation of subsidies, grants, tradable certificates or tax credits, perceived long term project risk, improved technologies, competitions lowered down the cost & reduced levelized cost of electricity generation.
10	Adnan Z. Amin (2017)	*Renewable Power Generation Costs in 2017*	Studied that globally accelerated renewable energy development happened due to technological innovation, enabling policies with impressive falling renewable power generation costs, competitive bidding with reverse auction, economies of scale in manufacturing & procurement, global supply chain, reduced O&M cost, access to international financial markets, large scale project experienced offers tremendous economic opportunities and challenges for scale up of renewable projects.
11	Jain (2017)	SWOT Analysis for Solar PV-Technology	Focused on SWOT analysis with strength of initiatives for number of solar projects in various states due to established solar technology, higher solar radiation in almost regions, world bank loan & incentives for development against this the weakness consist of high up front cost of capital, land

			acquisition issues, inadequate grid interconnection issues, examined the opportunities of governments ambitious targets for solar projects, creation of jobs in market and threat of high risks of obsolescence, technological risk, non availability of experienced & trained.
12	Kószó (2016)	"Historical Growth, Current Situation and Future Prospects of Wind Energy for Electricity Generation in Germany	Studied the Porter's five forces analysis on electricity market for the future scenario of renewable wind energy projects with ambitious targets by Germany and highlighted that the competition is dominated & influenced by four strongest companies keeping oligopolistic position, leaving almost low or even no space for internal rivalry, the entry is challenging due to high upfront capital cost, however in future scale up of projects with improved technology, the entry cost likely to reduce, but the competitive market barriers the new entrant.
13	Khatchadourian (2016)	Situational analysis of EU renewable energy legislation, Climate Policy."	Studied the restructuring of renewable energy policies needed after 2020 to enhance the deployment of solar & wind projects by applying the situational analysis tool, identified internal strengths(S) and weaknesses (W) with the external threats (T) and opportunities (O) by considering the factors like political and regulatory, financial and market and technology and infrastructure factors
14	Marlene Motyka (2015)	"US solar power growth through 2040 Exponential or inconsequential?	Studied and provided perspectives on the long-term growth trajectory for solar power in the US. The projected

			potential for continued exponential growth is worth due to exponentially declining costs and rapidly improving efficiency of solar panels. The challenges faced such as the cost of capital, enabling technologies, the rate of technological advances, grid integration, competition, addressable market, adoption level, cost for the evolution of policies such as fiscal incentives, utility rate reform, evolving financial structures, business models, and customer sentiment.
15	Bartłomiej Iglinski (2015)	Energy potential and future prospects for the development of renewable energy projects in the Wielkopolskie region, Poland	Presented the current state of infancy, energy potential and future prospects for the development of renewable energy projects in the Poland and concluded that the development of the renewable energy sector largely depends on the proposed legal legislation & regulations, increased subsidies, introduction of guaranteed certificate prices and awareness of public, investors, developers and decision-makers. The SWOT analysis concluded the significant potential for development of renewable energy projects
16	Grzegorz Piechota (2015)	The study on the SWOT analysis of renewable energy sector on the example of the Pomorskie Voivodeship . Poland:	Studied on the SWOT analysis on the existing state and growth prospectus of renewable energy sector Poland, analyzed that windy regions is the potential source favouring the development, Concluded that growth of renewable energy projects in Poland depended on framing of enabling policies & regulation, Renewable

			promotion policy, single window procedure for permission , financial support for new investments, guaranteed green certificate prices & increasing awareness among public, investors, decision-makers, developers etc.
17	Asok Rajkumar (2013)	Consolidated Renewable Energy – A Future Hawk-Eyed Energy In India ."	Studied the evolution of renewable energy potential at global and national level as the sources are affordable, accessible and secured, expressed with 4E's concept such as "Education, Engineering, Enforcement and Evaluation" , analyzed the strength, weakness, opportunities and threats (SWOT) of renewable energy sector in India, focused on the bottlenecks such as acquisition of lands, lack of renewable energy sources assessment, issues of funding the renewable energy project, insufficient transmission infrastructure, grants and subsidy, high upfront capital Project costs, financial barriers, support infrastructure and regulatory barriers
18	David Nelson (2012)	`Meeting India's Renewable Energy targets Climate Policy Initiatives`.	Studied the challenges for framing national policy that attract the investment needed to scale up rapid development in renewable energy projects both, wind and solar at viable cost, also analyzed and concluded that the impact of policies on delivered cost/ Levelised cost of electricity (LCOE) for actual renewable energy projects i.e. wind and solar projects, without any incentives using project-level parameters i.e. debt-rate, tenor and hurdle rate with

			maximum debt denotes the lowest cost of electricity possible from the projects,
19	Votteler (2012)	An Analysis of The Solar Service Provider Industry in the Western Cape.	Studied the adapted model of Porters' value chain & Porters' five forces analysis models for structural understanding, identifying business activities considering the external competitive environment of service providers in the South Africa & Western Cape solar industry
20	Ms Rita Roy Choudhury (2012)	Securing the Supply Chain for Solar in India	Studied the future demand opportunities, key challenges faced by developers & manufacturer for solar supply chain, recommended to established secure & cost effective supply chain system by examining the views of stake holders related to solar value chain to enables job creation, controls the outgoing foreign exchange, increased investment and long term sustainable growth of solar projects
21	Ahmed (1994)	Renewable energy technologies: a review of the status and costs of selected technologies	Studied that unit costs of renewable energy technologies significantly declines, further reductions in costs be expected with technological development, research & development in technology, incentives for further technical innovation in manufacturing extent of government interest, increased module efficiencies particularly with large-scale commercialization, market growth and economies of scale with large scale projects turns to reduction in uncertainties, ultimately reduction in cost of electricity.

Chapter-4 Research Methodology

4.0 Introduction:

Designing an appropriate, accurate and quality research methodology for the given problem is highly essential from the point of view of researcher. Therefore, due attention is paid for designing and then adhering to the appropriate research methodology throughout the research process for improving the quality of research.

4.1 Rationale of the study:

The Renewable energy is the key to the development of society and country as well. Moreover, the Government of India has set a goal of 175 Gigawatts (GW) cumulative renewable power installed capacity by the end of 2022 and submitted this Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention of Climate Change (UNFCCC). Further, India has set a target to increase the country`s share of renewable energy installed electricity capacity to 40 percentage by the end of 2030. NITI Ayog launched the India Energy Security Scenarios 2047 (IESS 2047), explores a range of potential future energy scenarios for India. As per MNRE annual report, so far cumulative installed renewable power capacity in India as of 31 March 2018 reached to 69.784 GW and as of 31 March 2019 reached to 78.316 GW. This indicates that India`s renewable energy (RE) potential is vast and largely untapped. As per IESS 2047, recent estimates show that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (may be higher than 1000 GW). It shows opportunity for achieving as high of 410 GW of wind and 479 GW of solar PV by 2047.

With respect to the enormous demand for power in India, the opportunity of renewable power is also growing. However, the untapped renewable energy resources of the country were not being put to optimum use preliminary due to various constraints and challenges/weakness for the financing investment for financier, investors, promoter, regulator of electricity and private power developer as well. This research study focuses on various dimensions of SWOT analysis, Porters five force analysis and provides such opportunities to bridge the gap between installed renewable energy capacity and untapped potential.

4.2 Statement of the problem:

As far as renewable energy is concern, it is one of the most important, live and vibrant topic for research. It is due to the fact that now a days every countries both developing and developed countries committed and focusing on the renewable energy projects due to environmental awareness, energy security of the country, naturally available sources of energy and lot many reasons best known to everyone, However due to some constraints, weaknesses, challenges and threats same is not being optimally utilised to the tune of availability. In this context various studied have been conducted regarding the renewable energy sources, financial & investment opportunities, awareness, Project cost effectiveness, regulatory policies, support mechanism, challenges, competitions faced by various developers, EPC contractors, policy makers, national & international players, consumers and people at large. Thus it seems to be important to have research study considering all aspect of renewable energy projects. Hence the descriptive and analytical study undertaken to identify and analyse the factors in terms of SWOT analysis and to find a suggestive overview. The statement of problem is as under:

"SWOT Analysis of Renewable Energy Projects"

4.3 Objectives of Research:

India has abundant natural resources and available resources are able to meet India's demand of electricity. In this context, it is felt important to research study and analyse the various issues / constraint / factors / parameters related to the development of renewable energy projects in India as well as renewable energy project development, globally to leverage the experience of developed countries, the analysis of which could help to address the various issues, constraints and weaknesses which prevents the implementation of renewable energy projects in India, thereby assist in identification of barriers, challenges and resolution of the issues amicably to encourage the exploitation of naturally available renewable energy resources.

In this reference, the objective of the present study is to examine the current Renewable Energy mix scenario of India and global as well, financing and investment opportunities, barriers and challenges associated with renewable energy projects, key driving policies and regulations', support mechanisms required for growth of sector, impact of cost

competitiveness, the recent market dynamics and to outline a suggestive overview of the possible approaches, policies/incentives to encourage the financing investment in Renewable Energy projects.

The study has the following specific objectives:

1. To understand the Global and Indian Renewable Energy mix scenario, available potential of renewable energy resources, present scenario of renewable energy projects, scope of development of Renewable Energy Projects.
2. To understand the changing scenario, key driving policies & regulations, support mechanisms for renewable energy projects.
3. To understand the developmental opportunities and strengths for renewable energy project.
4. To understand & analyse the manufacturing resources & value chain for development of renewable energy projects.
5. To understand the market dynamic & cost competitiveness for development of renewable energy projects.
6. To understand and analyze the challenges, weaknesses and threats of Renewable energy projects.
7. To study about the perception of stack holders on viability of Renewable Energy projects.
8. To outline a suggestive overview to overcome the challenges, weaknesses and threats associated with, for development of Renewable Energy projects.
9. Suggestive measures to utilize optimally the available potential of renewable energy sources and development of renewable energy projects sustainably.

4.4 Significance of the study:

The result of this study is helpful and valuable to stake holders, policy makers, financiers and investors, developers, EPC contractors, decision makers for both government and private sectors of our countries as well as to a broader international audience. This study also provides a sound literature for an academician and the research scholars to pursue further research in the area of renewable energy projects.

4.5 Research design:

The research design is conceptually overall research frame work or structure of the proposed research to be conducted. The research design is referred to as the blue print of a research study and is as good as the ``glue`` which holds all the elements of the research projects. Hence it is imperative that an appropriate and effective research design is to be prepared for initiating effective research process to put the perspective ideas in a shape. The research design is defined by different authors differently (Creswell, 2014) ``defines research design as a procedures used in collecting and analysing the measures of the variable as specified in research problems``. (E.Spector, 1981) defined that `` any scientific investigation, be it in the social or natural science, must begin with some structure or plan, which defines the number and types of variables to be studied and their relationship to one another this structure is termed as Research Design``. (E.McNABB, 2010) ``Research design stands for advance planning of the methods to be adopted for collecting the relevant data and the techniques to be used in the analysis, keeping in view the objectives of the research and the audibility of time and money.

In this study, the combination of two types of research design will be used:

- Exploratory research:
- Descriptive research

As per (W.Paul Vogt, 2012) Ideally, if the research employ combine research designs methods, researcher will get better (more valid) results. This is the exploratory and descriptive study of a SWOT analysis of the renewable energy projects. The study is in the form of exploratory research as no such study has been conducted so far. The purpose of the exploratory research is to achieve new things by going insight into the renewable energy projects and more accurately understanding & investigation of the objectives defined in the research through the literature reviews on the renewable energy resources, challenges, government regulatory policies and support mechanism, cost competitiveness and through the survey of the existing renewable energy projects. The descriptive natures of the study are based on the fact that the research describes the phenomenon existing in the renewable energy projects which helps to study the current situation of the renewable energy scenario. The descriptive research used to identify and obtain the information of the parameter or characteristics of the projects situations through the questionnaire to be

framed keeping the research objectives in consideration. More over the consequential conclusions can be drawn for the entire populations involved in the renewable energy projects industry.

4.6 Data collection:

4.6.1 Primary Data: The primary research data were collected through the structured non-disguised questionnaire in electronics form and physical form from the various employees and management personnel of prominent organizations, Independent power producers and financial institutions, stake holders, the utility scale renewable energy projects sectors both public sector as well as private sector developers and investors of organized sector, bulk purchasers and others who have been contributing significantly in the development and exploitation of renewable energy sources about perception of renewable energy.

4.6.2 Secondary Data: The secondary data were collected from reliable and authentic sources like published research papers, published articles, research reports, newspapers, and various authentic websites. The other data which will be used for the purpose of the study will be taken from books, e-books, internet literatures, magazines, journals and electronic media through both online and offline mode.

4.7 Designing of the Structured Non-Disguised Questionnaire:

The structured questionnaires were framed on the consideration of research objectives of the research study by identifying the research gaps in the review of literature carried out in the field of research study. The structured questionnaire consists of neutrally worded questions and selected stake holders involved in the field of utility scale renewable energy projects were asked to rate their perception for various concerned with the recent market dynamics, support mechanism, Opportunities, competitiveness, weaknesses & challenges faced by various stakeholders, perception of stakeholders on utility scale Renewable Energy Projects, particularly grid connected ground mounted solar PV projects and onshore wind power projects to utilize optimally the available potential of renewable energy sources and development of renewable energy projects sustainably, within the India and the stakeholders opinion on such. The structured non-disguised questionnaire is available as Annexure – I.

4.8 Research Population:

The population for the purpose of research consists of aggregate of all the individuals or elements or units of the universe that have some common set of characteristics. The population parameters for the research shall be typically in units or numbers say all the employees, management personnel, developers, investors, stake holders, institutions, consultant, financiers, equipment suppliers, EPC contractors in the field of utility scale renewable energy projects.

4.9 Target Population

Target population for present research is population under consideration that possess the information and characteristics that is required for the research and from the information of which inference are to be drawn. In the present research, the target population for the survey consists of organization, manufacturing units, consultant or individual involved in and have interest in the field of utility scale renewable energy projects in India and world as well. Here, the companies involved in and actively available in India and also, those global companies who have keen interest in the field of renewable energy and going to establish projects in India to exploit the untapped potential of renewable energy sources. Such target population for this research study comprise of the stake holders, policy makers, financiers, investors, developers, Regulators, R&D institutions Consultants, EPC contractors, decision makers, Service providers, Equipment supplier, EPC companies select employees & management personnel's of public sector and private sectors as well as Academicians of our countries. Over and above, international experts in the field of utility scale renewable energy projects were also included in target population.

4.10 Sampling element:

The sampling element is the people or the object chosen from the population of interest usually as respondent or participation in the research study which truly represent the population, from which the information as desired in survey is obtained. Based on which the inferences about that population is to be drawn. In the present study, the questionnaire related to survey is designed to obtain information on various traits or aspects of the renewable energy projects which have or likely have influence on the research topic, the sampling elements constitutes deciding authorities, middle or senior management

professionals of respective organisations/ institutions / companies or contractors academicians or have involvement or association with the utility scale projects and have influence on the decision making.

4.11 Sampling Frame:

Sampling frame consist of the list, published list of sampling unit or group of stack holders, organisations or regulators, consultants, policy makers of the identified target population. The select respondents have a stack in the utility scale renewable energy projects shall identified as part of sampling frame.

4.12 Sample Design:

In this research, the sample design on the basis of suitability and availability of the requisite sampling frame will be used. Here, stratified random sampling method will be preferred by the researcher to select the employees, developers, investors, stake holders, institutions in the field of utility scale renewable energy projects.

4.13 Sampling Technique:

A stratified sampling technique is used during the data collection process. As per stratified sampling process, the target population were divided into different stratum such as suppliers, EPC contractors, Stake holders, Consultants, Service providers, Policymakers and Regulators, decision makers, senior management, academicians, Public Sector Organizations and Private Sector Organizations involved in solar and wind utility scale renewable energy projects. Number of elements or units from each sample strata in selected group is finalised based on the available units (elements) in that strata.

4.14 Sampling Unit:

Sampling Unit is the available object or element from which of sample is done. In the present research study a sample is selected from the stake holders, policy makers, financiers, investors, developers, policy makers, Regulators, R&D institutions Consultants, EPC contractors, decision makers, Service providers, Equipment supplier, EPC companies, institutions, select employees & management personnel's of public sector and private sectors, Academicians of India and international experts in the related fields.

4.15 Sample Size determination:

The exact percentage or number of representative sample element (units) from selected each stratum from suppliers, EPC contractors, Stake holders, Consultants, Service providers, Policymakers and Regulators, decision makers, senior management, academicians, Public Sector Organizations and Private Sector Organizations involved in solar and wind utility scale renewable energy projects is considered as sample for research study. As each stratum is having more homogeneous characteristics than the other stratum, thereby estimating each of the stratums more accurately leads to better estimate of the Target population, hence stratified sampling method is used to have more reliable, accurate and detail information. However, the exact sample size determination for the purpose of collection of the primary data is calculated as below:

Formula for determining Sample Size:

$$\mathbf{n = \pi\ (1 - \pi)\ z^2 \div D^2}$$

Where,

n = required sample size.

π = the estimated population proportion (based on the researcher's judgment and estimate that 75 per cent (0.75) of the target population involved in Renewable Energy Projects.

z = Considering 95 per cent confidence level, gives the associated z value of 1.96, per normal table.

D = the level of precision and desired precision is such that the allowable interval is set as D = p (sample proportion) – π (population proportion) = + or – 0.05.

This formula used from Naresh K. Malhotra and Satya Bhushan Dash (2011) 'Marketing Research – An Applied Orientation' 6th Edition, Pearson, Page number 364.

According to the given formula, the Sample Size is works out as under:

$n = \pi\ (1 - \pi)\ z^2 \div D^2$

$n = 0.75\ (1\text{-}0.75)\ (1.96)^2 \div (0.05)^2$

$n = 0.75\ (0.25)\ (3.8416) \div (0.0025)$

$n = 0.75\ (0.25)\ (3.8416) \div (0.0025)$

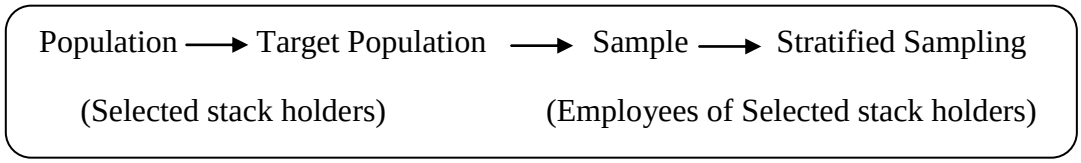
$n = 0.6375 \div 0.0025$

n = 255.12 so, sample size is round off with 255

Representative sample taken from various select employees & management personnel's of the Renewable Energy projects companies/stakeholders as under:

Sr. No	Stakeholders	Approx Numbers	Number of Management Personnel	Total Numbers
1	Developers	8-10	4-5	55
2	EPC contractors	10-12	4-5	65
3	Consultant	6-8	3-4	10
4	Regulator / Policy maker	3-4	2-3	10
5	Investor/Financier	6-8	3-4	28
6	R& D Institutions / Academicians	4-5	2-3	10
7	Equipment Supplier	8-10	3-4	40
	Total			**255**

The sampling process in flow chart mode is as under:



4.16 Reliability and Validity of the study:

According to the (Silverman, 2004) ``Reliability is the degree to which the finding of the research are independence of the accidental circumstances``. Validity on the other hands, according to (James H McMillan, 2001) , is the degree to which the interpretations and concepts have mutual meanings between the participant and the researched. According to (Dr. P. Narayan Reddy, 2008) ``the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability``. In other words, if the results of the study can be reproduced under a similar methodology, then the research instrument is considered to be reliable while validity determines whether the research truly measures that which it was intended to measure or how trustful

The reliability and validity for conducting any research study is very crucial aspect. In conceptual terms validity refers to the extent to which the data collecting tool is accurately measured what is intends to measure. For example, a research survey designed to explore depression but if it actually measures anxiety, than conceptually the survey is not to be considered as valid. The other measure of quality in a research quantitative study is reliability, or the accuracy or consistency of a survey. In other words, the extent

to which a research tool consistently has the same results if it is used in the same situation on repeated occasions. The reliability and validity is thus very useful in drawing error free conclusions from the collected data. In order to ensure reliability and validity of this research study, consistency and accuracy in data collecting tools or survey questionnaire has been formulated in consultation with experts in the field of renewable energy sectors and the content is updated as per the requirement of the research study.

4.17 Research gaps identified in the literature review:

The researcher gone through various research studies regarding the renewable energy carried out in past. The review of literature made it clear that no study had been carried out in the Indian context in the area of SWOT analysis of renewable energy Projects as Holistic Approach –Strength, opportunities, weakness, challenges and to provide suggestions /recommendations for tapping the untapped potential of renewable energy sources in India in view of SWOT analysis. This has encouraged me to work on this topic. In this proposed research study, I try to bridge this gap in the literature.

In this present study, I have to make number of recommendations / suggestions regarding future drivers to encourage stake holders, policy makers, financiers and investors, decision makers for both government and private sectors and financial institutions of our countries as well as to a broader international institutions to invest in a right way & fearlessly for the uninterrupted growth of renewable energy in utility scale to tap the untapped renewable energy sources potential provided by the nature free of cost and free of pollution which might be helpful to meet the massive target, ultimately helps in pollution free and sustainable India. As the entire world is grappling with the problem of acute shortage of energy, energy security, pollutions which is so vital for all developmental activities. To meet the ever increasing demand, fossil fuels such as coal, oil and natural gas have been overexploited in an unsustainable manner. In this critical situation, new and renewable sources of energy are most viable options for the future concerning the sustainable energy and locally available in abundance.

4.18 Variable under Study:

Independent Variables

- Challenges and barriers
  - ✓ Financial challenges
  - ✓ Evacuation issues
  - ✓ Costing barriers
  - ✓ Competitive barriers
  - ✓ Technical barriers
  - ✓ Awareness barriers
  - ✓ Investment barriers
- Policy & Regulatory
  - ✓ Policy barriers
  - ✓ Regulatory framework
  - ✓ Support mechanism
  - ✓ Political & Institutional barriers
  - ✓ Government taxes, GST & duties
  - ✓ Safe Guard Duties
- Financial Investment:
  - ✓ Investors interest
  - ✓ Availability & Interest on loans
  - ✓ Return on Investment
- Manufacturing / suppliers
  - ✓ Manufacturing capacity available
  - ✓ Product up gradation
  - ✓ Raw materials availability
- Value chain
  - ✓ Market competitions
  - ✓ Logistic & delivery
  - ✓ Materials availability
  - ✓ Cost competitiveness
- Cost of projects development
  - ✓ Cost of materials
  - ✓ Cost of equipment's
  - ✓ Cost of land
  - ✓ Cost of labours
  - ✓ Taxes & duties

Dependent Variables

- Renewable energy resources potential:
  - ✓ solar radiations, wind flow, weather conditions
  - ✓ Differ at Various regions of India
- Renewable energy project capacity development
  - ✓ site availability, evacuation facility availability,
- Renewable energy project viability
- Government Target
- Stake holders perception

4.19 Hypothesis Formulation:

(Kothari, 2004) ``When a predicted or hypothesized relationship is to be tested by scientific methods is a research hypothesis and is a predictive hypothetical statement which relates independent variables to a dependent variable``. Here, independent variables as well as dependent variable are defined and accordingly, the hypothesis statement is prepared. Following are the major hypothesis to be tested with appropriate statistical tools.

Main Hypothesis:

H_{01} There is no significant relationship between available renewable energy potential and development of utility scale renewable energy projects.

Other Hypothesis:

H_{02} There is no difference in renewable energy potential at various regions of India.

H_{03} There is no difference between central and various state policy & regulations for renewable energy projects developments.

H_{04} There is no significant relationship between available renewable energy potential and government target.

H_{05} There is no significant relationship between government policies and government target.

H_{06} There is no significant relationship between available renewable energy potential and cost of renewable energy projects development.

H_{07} There is no significant relationship between available manufacturing resources and renewable energy projects development.

H_{08} There is no association between challenges or barriers and developments of renewable energy projects.

H_{09} There is no significant relationship between cost competitiveness and renewable energy project development.

H_{10} There is no significant relationship between financial investment and development of renewable energy projects.

H_{11} There is no significant relationship between project cost and viability of renewable energy projects.

H_{12} There is no significant relationship between value chain and effect on renewable energy projects developments

H_{13} There is no association between perception of stack holders and viability of renewable energy projects.

H_{14} There is no association between stake holders' awareness and development of renewable energy projects.

4.20 Limitations of the study:

- As the data may be collected through the questionnaire there may be possibility that employees, management personnel, developers, investors, stake holders, institutions may not be fully loyal in answering the questions, also there is bias mind due to company to company competition which may cause misleading data.
- Due to work pressure and lake of time, interest as well as knowledge of the employees they may not fill the questionnaire properly.
- The Time Constraint in collecting the responses is one of the limitations as the data will be collected from out station developers, investors, stake holders, institutions within the period of one year, would be a limiting factor.
- The Cost Constraint is limiting factor as the increased sample size increases the cost of data collection.
- The sample size may not adequately represent the entire population.
- The data is collected from government, PSU organizations and private sector related to the research field. Hence the result may or may not be generalized.

4.21 Delimitations of the study:

- The studies is delimited to the large utility scale ground mounted solar photovoltaic (PV) and onshore wind renewable energy projects in Indian geographical boundary and not considers the small scale renewable energy projects hence, analysis and recommendations for tapping of untapped renewable energy sources and development of such renewable energy projects have been done.
- This study will not considered small scale hydro, solar heating system, solar rooftop, Concentrated solar projects, waste to energy, tidal power, geo thermal power, bio gas/biomass/baggage base projects, offshore wind projects and other form of renewable energy projects.

- This study will not criticize any policy, act, regulations, targets or guidelines provided by any of the Government. Also will not provide any specific recommendations on any private or government organizations/ institutions which are outside the scope of the report.
- The study also will not explicitly examine the effect of climate change legislation in the form of an economy-wide cap or tax on greenhouse gas emissions, on bilateral cooperation in renewable energy, although it will describe how these mechanisms could affect the market for renewable energy power projects. Such legislation or a global agreement to reduce emissions would eventually influence the structure, financing and is motivated by a range of factors.

Chapter-5 Data Analysis & Interpretation

5.0 Data Analysis & Interpretation:

(Holliday, 2007) ``Data analysis is the process of making sense of the data and discovering what it has to say``. The present study is of SWOT analysis of Renewable Energy Projects in terms of development and tapping of untapped renewable energy and financial investment in the renewable energy.

- ⇒ The approach adopted is basically analytical and descriptive in nature.
- ⇒ Collected Data Analysis will be done extensively and the area of research which needs more attention and elaboration will be studied.
- ⇒ On the basis of the literature review and objectives of this study, Researcher uses the business model to analyse and interpret the related parameters.
- ⇒ Systematic Literature Review (it is a critical & in depth evaluation of previous research) method, have also been applied.
- ⇒ The primary data collected with the help of structured non-disguised questionnaire and through interviews, which are being scrutinized, edited, classified and tabulated. Thereafter the data are being presented in the form of Tables, Charts, Graphs, Diagrams and analysed as required.
- ⇒ The collected data are being analysed with the help of appropriate statistical and mathematical tools and techniques for quantitative analysis includes Statistical Package for Social Sciences (SPSS), excel software applications used for calculation of Measures of Central tendency, Dispersion, Correlation.
- ⇒ Regression Analysis, ANOVA and Testing of Hypothesis techniques, as required, are also used by the researcher for the purpose of analysis of data.
- ⇒ The other analysis used is discounted, SWOT analysis, porters five force analysis etc.
- ⇒ Analysed data are being interpreted to established meaningful relationship among variables under study and to arrive at the recommendations & conclusions..

Chapter-6 Findings, Recommendations and Conclusions

6.0 Findings, Recommendations and Conclusions:

Initial portion of this chapter deals with the findings such as the Multiple Regression Analysis and the Testing of the Hypothesis. On the basis of the findings recommendation will be made. Scope of further research will also be discussed in detail at the end of the thesis.

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Annexure-I:

Questionnaire

Questionnaire

The Questionnaire is for research study concerned with the recent market dynamics, support mechanism, Opportunities, competitiveness, weaknesses & challenges faced by various stakeholders, perception of stakeholders on Renewable Energy Projects, particularly grid connected ground mounted solar PV projects and onshore wind power projects to utilize optimallythe available potential of renewable energy sources and development of renewable energy projects sustainably, within the India and the stakeholders opinion on such. Survey being carried out purely for the purpose of academic research and the strict confidentiality will be maintained. The name of the organization and person will not be disclosed to any one. The conclusions of the study would be based on the information provided by you to the great extent. However, Researcher would be glad to share the research outcome provided you desire.

Please complete and submit the response at earliest. Your time and cooperation is greatly appreciated.

Thank you.

1. Name of the Respondent: _____
2. E-Mail ID: _____
3. Designation: _____
4. Name of Organization: _____
5. State of the Respondent: _____
6. Total years of Experience:
   - **a.** Up to 2 Years
   - **b.** 2 to 5 Years
   - **c.** 5 to 10 years
   - **d.** More than 10 Years
7. Type of Organization:
   - **a.** Private
   - **b.** Public
   - **c.** Joint Venture
   - **d.** Government
   - **e.** Non-Government
8. How do you contribute to a utility scale renewable energy project: As a (please, specify).
   - **a.** Manufacturers
   - **b.** Supplier
   - **c.** EPC Contractor
   - **d.** Project Developer
   - **e.** Investor
   - **f.** Financier
   - **g.** Policy maker
   - **h**. Consultant
   - **i.** Power Purchaser
   - **j.** Independent power producer
   - **k.** Captive Users
   - **l.** Research Institution
   - **m.** Promoters of Renewable Energy
   - **n.** Renewable Energy Power Trader
   - **o.** If others, please specify _____

9. Please rate on scale how each one of the following stakeholders are responsible / contributor for the development of renewable energy projects (solar & wind).

Stakeholders	Strongly Agree	Agree	Don`t Know	Disagree	Strongly Disagree
Manufacturers					
Supplier					
EPC Contractor					
Project Developer					
Investor					
Financier					
Policy maker					
Consultant					
Power Purchaser					
Independent power producer					
Captive Users					
Research Institution					
Promoters of Renewable Energy					
Renewable Energy Power Trader					

10. In how many sectors within the Renewable Energy basket you have been Operating:

a. On -Grid Connected Solar PV Power Projects

b. Off-Grid Conneced Solar PV power Project

c. On Shore Wind Power Projects

d. Off Shore Wind Power Projects

e. On grid Solar Wind Hybrid Projects

f. Floating Solar Power Projects

g. Small Hydro Power Projects

h. Bio mass projects

i. Concentrated Solar Thermal Power Projects

j. Geo thermal Power Projects

k. Tidal Power Projects

l. Waste to Energy

11. Rate on a scale regarding "potential of Solar Renewable Energy in India"

	Strongly Agree	Agree	Don`t Know	Disagree	Strongly Disagree
India has a tremendous potential of solar radiation					
Different state/area have different solar energy potential					
There is tremendous scope of solar Power project development					
The target of 100 GW of Solar power project will be achieved upto 2022					
Installation of solar power projects are growing at a speed as desired which may fully utilized the available solar resources potential of 750 GW					

12. Rate on a scale regarding "potential of Wind Energy in India"

	Strongly Agree	**Agree**	**Don`t Know**	**Disagree**	**Strongly Disagree**
India has a tremendous potential of wind energy					
Different state/area have different wind energy potential					
There is tremendous scope of wind Power project development					
The target of 60 GW of wind power project will be achieved upto 2022					
Installation of wind power projects are growing at a speed as desired which may fully utilized the available wind resources potential of 310 GW					

13. Rate: 1- Available more than target requirements, 2- Sufficiently Available to meet the target requirements 3- available less than target requirements, 4- Not available at all 5- Not known

What do you say about the available RE potential for achievement of Govt. target.	1	2	3	4	5

14. Rate: 1-Very Important, 2-Important, 3-Neutral 4- Less important, 5- Not at all Important

Rate your opinion on scale to support for the achievement of government target of Renewable Energy Projects.	1	2	3	4	5

15. How important for your organization to support for the achievement of government target of following Renewable Energy Projects. (please rate by tick mark)

	Very high (80% or more)	**High (50% - 80%)**	**Moderate: (50% - 20%)**	**Low (less than 20%)**	**Not significant**
Solar PV Power projects					
Wind Power Project					

16. Considering Renewable Energy Projects sector, how significant it for your organisation to install renewable energy projects in order to utilize optimally the available potential of renewable energy source in the following sectors. (please rate by tick mark)

	Very high (80% or more)	**High (50% - 80%)**	**Moderate: (50% - 20%)**	**Low (less than 20%)**	**Not significant**
Solar PV Power projects					
Wind Power Project					

17. Rate the following factors influencing the decision of installation of renewable energy (Solar & Wind) projects

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Payment security mechanism					
Centre level policy supports					
State level policy support					
Easy of procedure for RE project					
Land policies					
Low cost funding from Government institutions					
Low cost funding from Private Banks and Institutions					
Policy for disposal of solar panels					
Availability of facility for disposal of solar panel					
Development of Solar Parks at different states					
Waiver of transmission & wheeling charges					
Renewable Purchase Obligation (RPO)					
Exemption of custom duties					
Imposition of safeguard duty					
Availability of renewable energy resources					
Availability of off takers					
Availability of evacuation facility					
Market competition					
Government target for RE capacity					
Supply chain network					

18. Rate the factors restricting the installation of renewable energy projects

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Government target					
Policy implementation					
Renewable Purchase obligation					
Policy of land for solar & wind Project					
Transmission infrastructure facility					
Power purchase issues					
Market competition					
Custom & safeguard duty					
Non-Availability of lands					
Inadequate material supply					
Awareness & skill manpower					

19. Rate the following constraints for Renewable Energy project capacity development with respect to available RE potential

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Acquisition					
State Development Energy Authority registration, Approval and inspection of project					
Supply chain issues					
Transmission infrastructure availability & Evacuation facility					
Taxes and duties like Custom duty, safeguard duty, variable taxes					
DISCOM Payment issues					
Financing issues					
Non availability of solar parks					
Off-takers issue					
General issues					

20. how far the existing policies and supports helps in developing and achieving the government target particularly solar PV target of 100GW & wind target of 60GW respectively.

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
100 GW Solar PV Projects					
60 GW Wind Power Projects					

21. Do you agree that development of renewable energy projects creates opportunities of green employment to boost the India`s developing economy

	YES	**NO**
Solar PV Power Projects		
Wind Power Projects		

22. If yes, tick mark the approximate nos of green employment generation upto life cycle of utility scale renewable power projects capacity addition

	Less than 10 job-year per MW	11 to 15 jobyear per MW	16 to 20 jobyear per MW	21 to 25 jobyear per MW	26 to 30 jobyear per MW	More than 31 job-year per MW
Solar PV Power Projects						
Wind Power Projects						

23. To what extent the following policies help to promote the government target for development of Renewable (Solar & Wind) energy projects.

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Accelerated Depreciation					
Feed in Tariff					
Preferential Tariffs					
Generation Based Incentives (GBI)					
Exemption from custom duty					
Renewable Energy Certificates					
Renewable Generation Obligation					
No inter-state transmission charges					
Viability Gap Funding					
Central Financial Assistance					
Imposition of Safeguard duty					
Budgetary support for R&D and demonstration of technology					
Income tax holidays					
Competitive bidding process					
Foreign Direct Investment					
Funding from government institutions for financing term loan					
Introduction/revision of solar policy					
Enforcement of Renewable Purchase Obligation					
Hybrid solar wind policy					
Policy for revamping of existing solar-wind projects					
Payment Security mechanism					
Off-takers- Power Purchase Agreement					

24. To what extent the following as the opportunity for the development of Renewable Energy Projects

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Government mandate for target					
Renewable Energy Resource Potential					
Renewable Purchase Obligation (RPO)					
Policy & Regulatory supports					
Waival of inter-state transmission charges					
Domestic manufacturing facility					
Duty free Supply chain from other countries					

25. Please opine what percentage of RPO is to be enforced for achievement of government target of 175 GW by 2022.

10 to 12%	13 to 15%	16 to 18%	19 to 21%	21 to 24%	More than 25%

26. To what extent the following challenges / barriers affect for the developments of utility scale renewable energy projects

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Technology Development					
Supply chain issue					
Taxes and duties					
General Infrastructure development					
Geographical and ecological barriers					
Lack of knowledge and awareness of technologies barriers					
Financial and economical barriers					
Policy & regulatory barriers					
Market related barriers say lack of business model, Lack of defined market					
Initial investment / upfront cost					
Transmission infrastructures development					
Land acquisition issues					
Political issues					
Forecasting & Scheduling / DSM					

27. Is there any difference for utility scale renewable energy project developments at various regions in terms of following factors?

	Very large Difference	**Large Difference**	**No difference at all**	**Less Difference**	**Very less Difference**
Regional RE resources / potential					
State Policy					
State Regulations					
Regional Challenges					
Regional Barrier					
Ease of doing business					
Payment Security					
Awareness & Capacity building					
Forecasting & scheduling/DSM penalty					

28. To what extent the following govt policies are supportive for investment in utility scale renewable energy projects.

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Amendment in tariff policy 2015 (Reduction in tariff cost)					
Waiver of transmission charges (Promoting grid connectivity)					
Financial support from government institutions					
Defined Renewable Purchase obligation (RPO)					
Promoting Research & Development					
Promoting expansion of market					
Repowering policy					
Import taxes, Custom duties, Safeguard duties					
Financial and Promotional Initiatives					
Promoting supply chain from other countries					
Removal of feed in tariff					
Introduction of competitive bidding					

29. Which policy you propose for supporting the investment in utility scale renewable energy projects

a. Payment Security mechanism

b. Land Acquisition policy

c. Infrastructure development policy

d. Policy and other regulatory support mechanism

e. Establishment of Green corridor

f. Foreign Direct Investment (FDI) relaxed policy

g. Establish important promotional policy

h. Competitive bidding process

i. Connectivity at Project site

j. Solar park policy

k. If others, _____

_____

30. To What extent the following policies & regulatory level barrier affect the development of utility scale renewable energy projects to utilize available potential of RE potential

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Policy barriers					
Regulatory barriers					
Support mechanism barriers					
Political barriers					
Environment barriers					

Land policy barriers					
Power purchase policy					
Institutional & Administrative barrier					
Public acceptance barrier					
International Trade barrier					

31. To what extent the functional and operational level barrier & challenges affect the development of utility scale renewable energy projects to utilize available potential of RE potential

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Financial challenges					
Evacuation issues					
Costing barriers					
Competition barriers					
Technical barriers					
Infrastructure barriers					
Investment barriers					
Awareness & capacity development barriers					
Sale of power barriers					
Forecasting & scheduling barrier					
Land acquisition barrier					
Deviation Schedule Mechanism (DSM) penalty barrier					
Supply chain barrier					

32. What are the current challenges / barriers in installing renewable energy projects for your organization?

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Distribution & transmission facilities					
Frequent changes in state policies					
Difficulty in funding project					
Financing cost					
Reduced tariff					
Variable output					
Initial investment					
Market Competition					
Cost Competition					
International trade issues					
Competitive bidding process					
Local Taxes & duties					
Safe guard & anti dumping duties					
Domestic Content Requirement (DCR)					

33. As per your perception, pl rate the following general barriers that affect development of utility scale renewable energy projects both solar & wind

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Frequent changes in state level regulations					
Difficulty in finding buyers for generated electricity					
Investment cost					
Operation & Maintenance					
Seasonal availability of renewable resource					
Distribution companies not willing to buy beyond Renewable Power Obligation (RPO)					
Process for obtaining Renewable Energy Certification (REC)					
Wheeling & supervision charges.					
Procedure for permission, registration Etc					
Procedure for connectivity					

34. What are the procedural issues encountered in development of utility scale renewable energy projects in India?

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35. Which range of project costing is viable for the utility scale renewable energy projects capacity in MW AC in India?

	6 to 5.5 Cr per MW	5.5 to 5 Cr per MW	5 to 4.5 Cr per MW	4.5 to 4 Cr per MW	4 to 3.5 Cr per MW	3.5 to 3 Cr per MW
Grid connected Solar PV power projects						
Onshore Wind power projects						

36. How sensitive the market competition for the development of utility scale renewable energy projects.

	Extremely High Sensitive	Highly Sensitive	Neutral	Less Sensitive	Not at all sensitive
Utility Scale Solar Power Project					
Utility Scale Wind Power Project					

37. How sensitive the cost competition for the development of utility scale renewable energy projects.

	Extremely High Sensitive	Highly Sensitive	Neutral	Less Sensitive	Not at all sensitive
Utility Scale Solar Power Project					
Utility Scale Wind Power Project					

38. What is your perception regarding the initial cost of the setting up of renewable energy projects

	Very High initial Cost	High initial Cost	Normal initial Cost	Low initial Cost	Very low initial Cost
Utility scale solar PV power projects					
Utility scale wind power projects					

39. What do you think about the Operation & maintenance cost of the renewable energy projects

	Very High Cost	High Cost	Normal Cost	Low Cost	Very low Cost
utility scale solar PV power projects					
Utility scale wind power projects					

40. Which kind of assistance/support expected from the government for development of renewable energy projects in India?

a. Financial Assistance
b. Supportive Policy assistance
c. Purchase of power assistance
d. regulatory assistance
e. Capital subsidy assistance
f. Land acquisition support
g. Transmission infrastructure support
h. Assured connectivity at all locations
i. Procedural assistance
j. Right of ways support
k. supply chain assistance
l. Custom duties & taxes waival
m. Anti dumping/safeguard duty waival
n. Waival of inter-state transmission charges
o. If others, _____

41. Which kind of subsidy/incentives available at present from the government for development of renewable energy projects in the India?

- **a.** Green Certificate
- **b.** Support in the form of power purchase agreement
- **c.** Support in the form of payment mechanism
- **d.** Assistance in the form of loan
- **e.** Subsidized project grant
- **f.** Low cost loans
- **g.** supply chain support
- **h.** custom duty waival
- **i.** Anti dumping waival
- **j.** Waival of inter-state transmission charges
- **k.** If others,_____

42. To what extent the following points contribute to make utility scale renewable energy (solar & wind power) project more affordable and viable

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Government should provide more subsidy					
Invest more in R&D for technology development					
Promote domestic manufacturing capacity					
Implementation of policies					
Secured payment mechanism					
Power Purchase Agreement with Off-takers/DISCOM					
Waival of inter-state transmission charges					
Facilitate international trade					
Facilitate supply chain management					
Must Run status to RE power					
Waival of taxes & duties					
Awareness and capacity building					

43. How would you rate the criticality of each of the mentioned risks when it comes to investment in utility scale renewable energy projects say solar/wind power projects

	Extremely Critical	**Very Critical**	**Critical**	**Less Critical**	**Not critical at all**
Regulatory Risk					
Construction Risk say TIme over run & cost over run					
Counter Party Risk say Construction					
Contractor, O&M Contractor					
Financial Risk					
Investment Risk					
Power Off Taker Risk					
Resource assessment Risk					
Force Majeure Risk					
Deviation Schedule Mechanism (DSM) penalty Risk					

44. To what extent the following motivation support behind the decision on investing in utility scale renewable energy (solar & wind power) project?

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Renewable power are the future					
Returns on generations					
Congenial policies in renewable energy at state level					
High tariff rates					
Provision of Renewable Energy					
Certification					
Government targets for renewable energy development					
Lower operating cost					
Secured payment mechanism					
Availability of renewable energy resources					
Open access / third party sale of power					

45. So far as grid connectivity for evacuation of the generated RE power is concern, pl rate to what extent the following points affect the evacuation issues related with.

	To a very great extent	**To a great extent**	**To a moderate extent**	**To some extent**	**Not at all**
Inadequate transmission infrastructure					
Mismatch between the available corridor and necessary demand centres					
Procedure for connectivity permission					
High cost of establishment of transmission lines					
Right of Way (RoW) issues					
Transmission system Supervision charges					
Wheeling & transmission charges					

46. Rate: 1- more than sufficient 2- Sufficient 3- Less sufficient 4- Very less sufficient 5- Not sufficient

As per your experience, pl tick that the manufacturing capacity in India for major/main component of the utility scale renewable power projects are adequate to meet the increasing demand/ target set by government of India.	1	2	3	4	5

47. For execution of the utility scale renewable energy projects, pl rate the important the value chain, logistic, delivery of the materials at project site

	Very important	important	Less important	Very less important	Not important
Utility scale solar power project					
Utility scale Wind power project					

48. Rate: 1- very high cost 2- High cost 3- Equal cost 4- Low cost 5- Very low cost

Rate the cost comparison for procurement of materials from India & abroad.	1	2	3	4	5

49. From which country will your organization prefer to import main components for following renewable power projects?

Solar Power Projects	
Wind Power Projects	

50. In case for import of RE project component from other countries, pl rate the effectiveness of value chain, logistic, delivery schedule for project.

	Highly Effective	Effective	Less Effective	Very less effective	Not effective
Utility scale solar power project					
Utility scale Wind power project					

51. Which of the initiatives, as per your opinion shall be implemented for aggressive development of renewable energy projects to utilize optimally the available renewable energy resources?

a. Government mandated approach
b. Top down approach
c. Outcome based incentive approach
d. Incentive for domestic manufacturing capacity
e. Incentive for technology development
f. Time based incentive approach
g. Low cost long term loan
h. Market enabled research approach
i. Awareness & capacity building approach
j. Bottom up Approach
k. If other, _____

52. What would you suggest to utilize optimally the available potential of renewable energy resources and development of renewable energy projects?

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……

Thanks again for giving your valuable time to answer this questionnaire.

Annexure-II:

Published Research Paper

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A realistic glimpse into India's Energy Security in foreseeable future in view of renewable alternatives

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ABSTRACT

Energy Security plays a key role in the national security of any given country because without energy there is no economy, and without an economy there is no progress of society in general. In Indian context, electricity demand has grown at an average of 4 percent per annum over last 30 years. Currently, India is fulfilling their demand through domestic coal and oil and import of coal and oil playing a key role in India`s energy security. In this context, India is looking for long-term solutions to increase energy security by reducing dependence on foreign oil & coal import, as coal reserves available in India is to be kept as reserve for future. Keeping in view this fact and considering the environmental issues, Government of India declares the development of renewable energy with the available potential and targeted 175GW installed capacity by the end of 2022. With this prediction, renewable energy will decide the future energy security of India. Further looking to the growth of renewable and predicted amount of development in future the role of renewable energy is not to be overlooked and it supports the reduction in import of coal and ultimately ensures the energy security in future.

1. Introduction

Just like each country, India must think about its future energy security because this is one of the main prerequisites for the future economic growth of the country. Our economy is traditionally based on fossil fuels (coal, oil and natural gas), and this fact leads to conclusion that only the adequate supply of fossil fuels can ensure future energy security.

Energy security is term we often listen when the world running out of energy resources. In terms of this energy security refers to availability of natural resources for energy consumption in a given period of time in order to estimate future energy security.

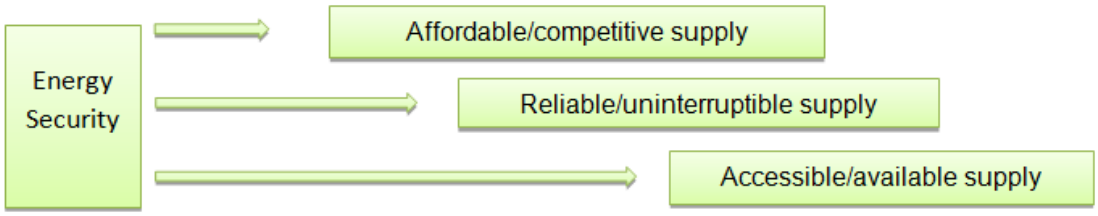
Despite the present development of renewable energy sources such as solar power, wind power and biofuels, fossil fuels as a energy sources in India are still under development sage. Under such scenario fossil fuels like coal and oil will continue to satisfy most of the nation's energy demand which determine the destiny of future global energy security. However, the role of renewable alternatives in improving energy security is not to be overlooked because more renewable energy coming from domestic renewable energy sources which may likely to reduces the need for fossil fuels and expensive coal import. The transition to more domestic renewable alternatives energy resources instead of relying on expensive foreign coal import could change the scenario and attempt to push aside the coal to make India's Energy Security in foreseeable future, at least till the end of the century

1.1 Energy Security –Concept

Until the 1970s, the concept of energy security was mainly emphasized the physical availability of energy, especially oil, however after the oil crises the concept propagated terms of price level, in either "affordable" or "fair" contexts. Especially since 1990s, on recognition of global warming issues by governments, the more explicitly sustainability is mentioned in terms of energy security. More recently, availability of energy supply issues are predominantly discussed under the concept of energy security.

Today, a typical definition of energy security is "the continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices" (APERC, 2007)[1] The IEA defines energy security as "the uninterrupted availability of energy sources at an affordable price". Energy security has many dimensions: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and sustainable environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance [2]. The extension of the IEA definition includes the environmental and sustainability issues that may introduce additional and sometimes disparate constraints. With further extensions to the original IEA definition, the Asia Pacific Energy Research Centre (APERC, 2007)[1] emphasizes the 'four A approach' - Availability, Accessibility, Affordability and Acceptability and defines energy security as "the ability of an economy to guarantee the availability of the energy supply resources in a sustainable and timely manner with the energy price being at an affordable level without affecting the economic performance of the economy".

Figure-1
Energy security in terms of Affordable/competitive, Reliable/uninterruptible, Accessible /available supply.



***Source**: APERC 2017*

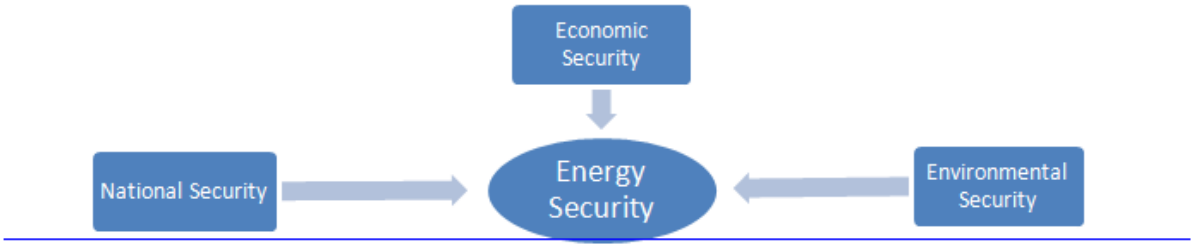
According to India's then president, A.P.J. Abdul Kalam, a scientist, demand for energy would be "a defining characteristic of our people's life in the 21st century" and defined energy security as "ensuring that our country can supply lifeline energy to all its citizens, at affordable costs at all times."

1.2 Significance of Energy Security

During World War I at the first decades of the 20th century, energy was first linked with national security, particularly with respect to security of oil supply for navy ships and vehicles and later in World War II [2] (2009) as well as by other papers (e.g. Sagan (1988)[3]). In the second half of the last century, the scope of energy security concerns significantly changed and it was no longer about stable and cheap supplies of oil protected from unilateral embargoes as in the 1970s, but involved other energy systems like natural gas, nuclear energy, electricity and civil transportations [4].

As per Wikipedia [5], **Energy security** is the association between national security and the availability of natural resources for energy consumption. Access to relatively cheap energy has become essential to the functioning of modern economies. However, the uneven distribution of energy supplies among countries has led to significant vulnerabilities.

Figure-2
Association between National, Economic and Environmental Security



Source: Wikipedia Energy Security

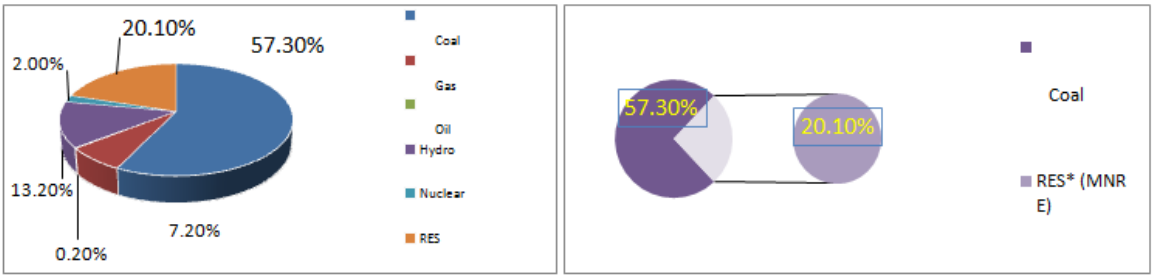
The APERC (2007)[1] report addressed four 'dimensions' of energy security (availability, adequacy, affordability, and sustainability) as 'multi-dimensional'. Such a multi-dimensional aspect of energy makes it a matter of national security.

1.3 Indian`s Energy Security Scenario

The sources of energy varies from age to age and since centuries the main sources of energy have been fossil fuels such as Coal, Oil and Natural Gas and these resources are now dominant in most of the developing countries of the World. India is the third largest coal producer in the World after China and the USA and Coal will continue to constitute a major proportion of India's energy mix for many years to come.

As per Power sector at a glance –All India GoI, Ministry of Power [6], the total installed capacity as on 31.03.2018 is 344GW, out of which the installed capacity based on coal constitute 199GW @ **57.3 %** and Renewable energy sources (MNRE) including solar, wind energy, biomass, small hydro, waste to energy etc constitutes 69GW @ **20.1%** as depicted in figure-3.

Figure-3
Total Installed capacity as on 31.03.2018 & share of coal & RE



Source: Power sector at a glance –All India GoI, Ministry of Power

2. Coal reserve position of India

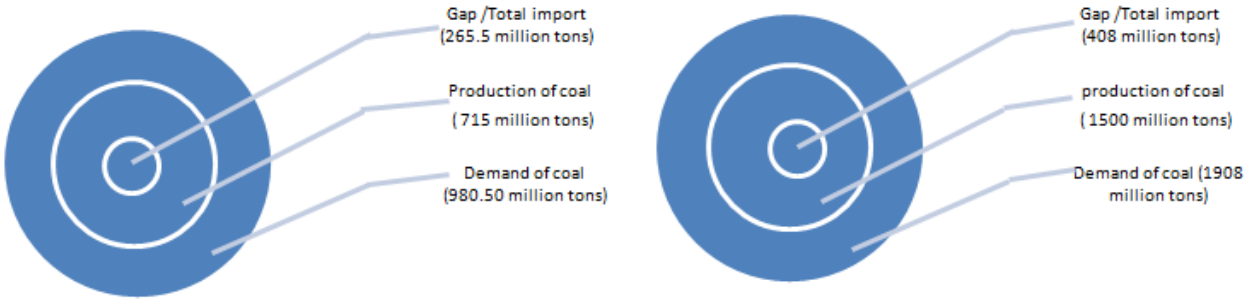
The total estimated coal resources of the country is 319020 million tonne as per "The inventory of Geological Resources of Indian Coal" (as on 01.04.2018)[7], prepared by the Geological Survey of India. The total coal extracted from the various coalfields during 2017-18 is 680.46 million tonne and since 1950 upto 2017-18 is around 15122.28 million tonne. (As per Coal Controller, MoC, Government of India)[7]. Every year about 3 to 5 billion tonne of resources are being added through fresh exploration to the Coal Inventory of India[8], which may create short fall over the period of time.

2.1 Coal Demand & Supply Scenario

As per the Report of the Working Group for coal & lignite in the terminal year of XII Plan (2016- 17) [9], the total demand of coal both cooking & non-cooking in different projections was at 980.50 million tonne. As against these demands the production of both cooking & non cooking coal are projected at 715 million tonne in the terminal year of XIIth Plan, creates a gap of 265.50 million tonne between demand and indigenous availability of coal which has to be met through imports.

In source wise projected demand of coal in the terminal year of XIII Plan (2021-22), is 1373 million tonne and indigenous availability of coal is projected as 950 & 1100 million tonne in scenario 1 and 2 respectively, creating a sizeable shortfall of 423 & 273 respectively. [9]

Figure-4:
The demand and production of coal under XII plan (2016-17) & projected scenario of demand and production of coal (2030) coal vision 2030 report (2018)



Source: Working Group for Coal & Lignite for XIIth Plan & coal vision 2030 report (2018).

2.2 Foreseeable Future of Coal

As per the draft National Energy Policy (NEP), (version as on 27.06.2017) formulated by the Niti Aayog, India Vision 2040 [10] envisages demand-driven provision of energy at affordable prices, high per capita consumption of electricity, access to clean cooking energy & electricity with universal coverage, low emission and security of supply as criteria that would characterize the energy parameters of India in 2040. The installed coal-based electricity generation capacity is expected to grow to 330- 441 GW by 2040. This is likely to translate into a coal demand of 1.1- 1.4 billion tonnes. The known levels of proven coal reserves (138 billion tonne as of 31.03.2016) may only be able to support an annual peak production of 1.2-1.3 billion tonne till 2037, with a gradual decrease thereafter.

According to the coal vision 2030 report (2018)[11] Coal to continue enjoying demand for some more time in India, even in the most adverse low sentiment scenario, as of 2017, it appears that the demand for coal in India, shall expand until 2030 and perhaps beyond to some extent.

Overall coal demand scenario is estimated to be 900–1,000MTPA by 2020 and 1,300–1,900MTPA by 2030 corresponds to a GDP growth rate of 8 per cent, as shown in Figure-4, which is influenced by economic growth, energy efficiency and emergence of alternate coal uses. By 2030, of the overall coal demand, thermal coal demand is estimated to be 1,150–1,750MTPA and the balance is coking coal demand.

The total production capacity of coal mines as on 2018 is about 1,500MTPA at the current rated capacity which is adequate upto 2020 as per current scenario. However, in the scenario where actual demand is higher, there is limited new mines in the immediate future, say 2022–25 horizons.

India is currently facing a number of energy security challenges, the gravity of which will increase in future as the demand for energy outstrips supply. As limited indigenous resources will not be sufficient to meet India's accelerated energy demands, in this context its dependence on the importing of oil, gas and coal will continue into the foreseeable future

2.3 Changing Scenario

During the 2017-18, the consumption of coal by the thermal power stations is almost stagnated, as the net capacity addition is negligible after accounting the retired thermal power capacity and the existing capacity operating at lower plant load factor (PLF) due to the fact that most of the incremental electricity demand is catered by the must run solar, wind, etc. as a part of energy security and to preserve the coal. Hence, utilization of available natural resources for energy generation is used to demonstrate energy security in a given short or long-term period by preserving domestic coal thereby reducing import of coal, in order to estimate future energy security

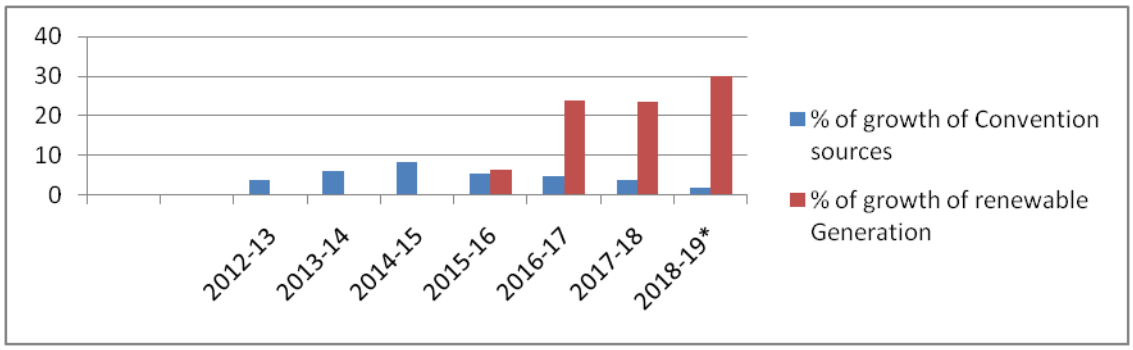
2.4 Role of Renewable Energy in Energy Security

In the changing scenario with growing concern on energy security, Government emphasized on Renewable Energy

projects development. Accordingly, the Government has up-scaled the target of Renewable Energy capacity to 175 GW by the year March 2022[13], which includes 100 GW from solar, 60 GW from wind, 10 GW from Bio-power and 5 GW from Small Hydro power and so far a total of 69 GW capacity has been installed through the implementation of various renewable energy schemes & programme upto 31st March 2018 and further installation continue.

The effect of schemes/policies envisaged the transition in electricity sector of India. The recent scenario witnessed that the accelerated renewable capacity addition of generation over the past few years lead to a situation wherein the electricity supply potential over reached the economic demand that had never happened before in the history of the Indian electricity sector. Accordingly witnessing changes in the energy mix due to enhanced policy focus on energy security concerns, climate change etc. due to which the penetration of renewable electricity, especially from wind and solar energy, has been increasing steadily during recent years [6] and is projected to grow much faster in the coming years as depicted in Figure-5 for the years 2026-27.

Figure-5: The %age annual growth in conventional & RE generation



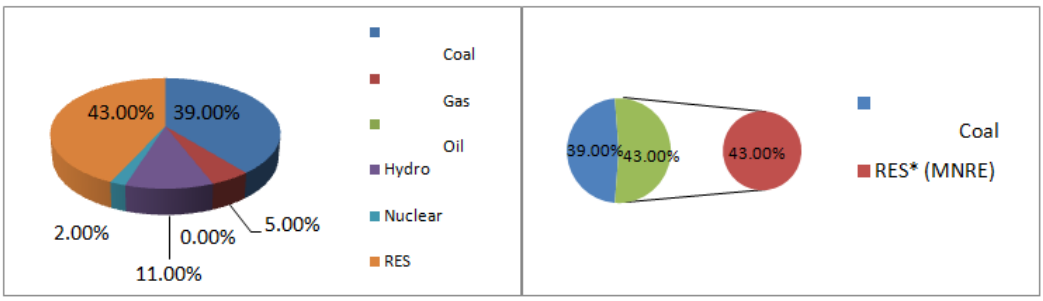
Source: Power sector at a glance –All India GoI, Ministry of Power

3. Projected Renewable Scenario

The Energy and Resources Institute (TERI) in their report `Transitions in Indian Electricity Sector report 2030`[12] studied and bring out possible transitions to address the changing demand and supply scenarios and made an assessment of electricity demand till 2030. The electricity demand scenario is built on the basis of extrapolating past demand to the future, taking into account the current year consumption and future economic growth and adjusting it to account for future end-use energy efficiency improvements, additional requirement for the households, industries and transportation.

As per the draft National Electricity Plan (December 2016) 13 , the supply side studied upto 2029-30, planned capacity additions of non-RE power i.e. coal, nuclear, hydro, and gas-based capacities of 50,025 MW, 7600 MW, 27,330 MW, and 4,340 MW, respectively. In case of coal-based power stations, the study has accounted for retirement of approximately 5.2 GW up to 2021–22 (as envisaged in draft NEP) and approximately 30 GW of capacity during the subsequent five years based on plant age, obsolescence of technology and environmental considerations. The likely installed capacity by end of 2026-27 works out to 640GW among which coal base capacity constitutes 248.5GW @ 39% including 50GW coal base addition currently under construction likely to yield benefit in 2017-22 and no coal base addition during 2022-27 and renewable energy constitutes 275GW @ 43%. India needs no extra coal power stations until at least 2027 as running and under construction coal plants meet demand until 2026-27, according to the government's latest draft National Electricity Plan. By that point, renewables and energy storage could be cheaper enough to provide all new capacity as per `The Energy and Resources Institute` (TERI) 201812.

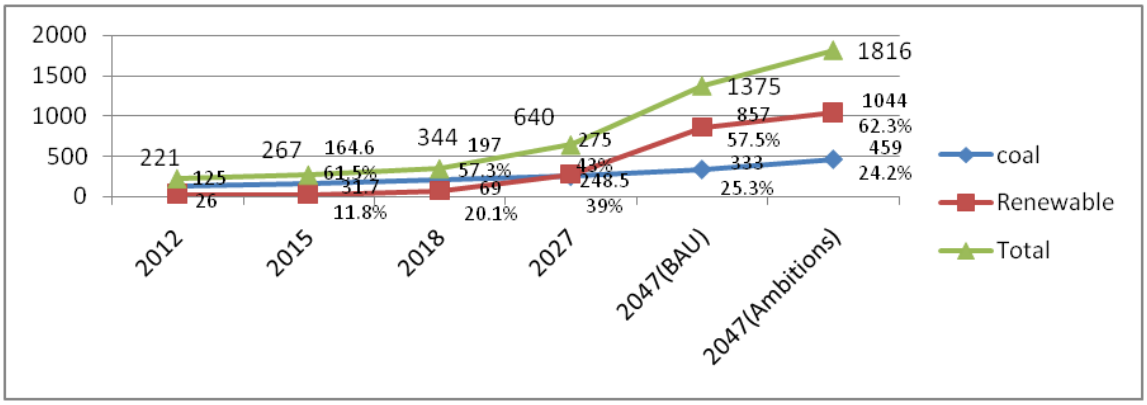
Figure-6: Projected Total Installed capacity during 2026-27 & share of coal - RE



Source: Draft NEP-2016

Now, for the better understanding, it is preferable to consider another study by NITI Ayog 2017 `energizing India`[14] projected data for 2047 indicates that India's energy consumption grows fastest among all major economies by 2047, depicted under figure 7 for better comparisons.

Figure-7: Existing & predicted Installed capacity 2012-2047



Source: Projected installed capacity data 2047 & 2012 NITI Ayog, Data of 2027 from NEP 2016, Data of 2015 & 2018 from CEA Report.

From the above Figure-7, it is predicted that since 2027 renewable energy begins to sideline coal, with the pace of renewable energy capacity additions more than doubling from the 2027 to 2047.

Outlook News[15] in their report Bloomberg new energy finance's (BNEF) predict that batteries and new sources of flexibility bolster the reach of renewables, the renewable energy will be reaching 49 percent in India as compared with just 17 percent upto 2017 by 2040. The long-term forecast suggests that the addition of renewable energy in the energy mix of the India's electricity system is unstoppable perhaps due to rapidly falling costs for solar and wind power. Considering such predictions, it is expected that the renewables will undercut the majority of fossil based generation by 2030. Alongside the growth of renewable sources generation capacities, supporting technologies such as storage will also continue their impressive growth. Besides this the electric vehicles also account for scale up of electricity generation which further slide down the cost proportionately for battery storage by 2030.

In such increased percentage potential for renewable energy sources in a country's energy portfolio means improved national energy security ultimately contribute towards reduction in dependency on imported fossil fuels but all current estimates concludes that the India`s economy will continue its dependence on fossil fuels until at the end of the century. Under such scenario, fossil fuels will continue to determine the destiny of future India's energy security.

However, the contribution of renewable energy in improving energy security is not to be overlooked because more renewable energy is being obtained from domestic renewable energy sources leads to reduced need for fossil fuels as well as expensive foreign fuel import, which is positive sign for a country's future energy security [16].

Though India having both conventional and renewable resources of energy, yet for such a large country, no single energy resource or technology constitutes a remedial cure to address all issues pertaining to the availability of fuel supplies, environmental impact and energy security as well. Therefore, it is need of the hour to integrate all diversified resources to be a part of an energy mix to ensure energy security to a country like India during the present century.

Renewable energy thus, has been an important component of India's energy security planning but renewable energy as an **`alternate energy`** will remains as **alternate source,** however will attempt to push aside coal from its high energy pedestal to some extent.

4. Conclusion

Each country must think about its future energy security because this is one of the main prerequisites for the future economic growth. Energy security will remain the core of India`s security and of all renewable energy sources will remain on the top agenda of India to meet the challenges in energy security for 21st century through the availability of electricity at affordable rate. While taking into account current rate of economic growth, the demand will grow much faster. India is one of the world's largest growing economies needs bulk of energy sources to fulfill requirements of its industries as well as expanding population. Currently, India is attempting to fulfill their demands based on fossil fuels (oil, coal and natural gas) and heavily relying on imported coal, petroleum and oil to meet its energy demands concluded that the supply of fossil fuel though limited available resources cannot guarantee future energy security. In such a critical situation, energy security for a state like India is undoubtedly a source of serious concern.

To meet these challenges, India has embarked on a 175GW renewable project to expand its available renewable energy potential. For India renewable energy is highly significant in context to energy security. Renewable energy is the most eco-efficient, cheaper and inexhaustible of all energy sources because of its free natural resources. In light of the abandon availability of natural resources in India, renewable energy is viable option for India to mitigate the issue of energy security. Despite the rapid growth in renewable energy, the literature review implied that the legacy coal plants will continue to generate thermal energy. However, most additional capacity in the country will come from renewable sources.

The role of renewable energy in improving energy security is not to be overlooked because more renewable energy coming from domestic renewable energy sources means less need for fossil fuels and expensive foreign fuel import.

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